Integrated Aquatic Vegetation Management Plan

SAMMAMISH RIVER

King County, Washington

Prepared by King County
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EXECUTIVE SUMMARY

The Sammamish River is a 13.5-mile-long waterway that connects Lake Sammamish to Lake Washington. The basin drains a 240-square-mile watershed that is comprised of the Sammamish River, Bear Creek, Little Bear, Swamp Creek, and North Creek basins. The River is part of the Lake Washington watershed and is in Water Resource Inventory Area 8. Many municipalities are along the river, including Bothell, Woodinville, Kenmore, and Redmond. Land use along the river ranges from agricultural to industrial to public and private.

Once a series of wetlands and slow moving water connecting the two large lakes, the river was straightened and dredged for commerce from the early 1900's through the mid-1900's. It is no longer used for commerce and today there is public access to the river which is enjoyed for canoeing, kayaking, and fishing. Along most of the river there is a popular walking/biking trail that spans from Bothell to Marymoor Park. City and county parks along the river provide many public access points to the water which are used for birding, wildlife watching, fishing, dog recreating, and hand-launch boat access.

The river provides important habitat for many different types of wildlife. Birds and small mammals use the river banks for forage and shelter and many aquatic animals use the river for both the important habitat and access to other ecologically important areas. The river is used by several key salmonid species for spawning, rearing and passage. Chinook, Coho, Sockeye, Kokanee, Steelhead, and Coastal Cutthroat are salmonid species known to currently inhabit the Sammamish River system (Kerwin, 2001).

Invasive noxious weeds have been identified in the river system and pose threats to water quality and aquatic habitat. Four weeds: purple loosestrife (*Lythrum salicaria*), garden loosestrife (*Lysimachia vulgaris*), common reed (*Phragmites australis)* and Brazilian elodea (*Egeria densa)* are particularly critical for removal. These four target weed species are all classified as Class B weeds on the King County noxious weed list, being limited in distribution and a local priority for control. All are designated for control in King County except Brazilian elodea which is a non-regulated weed in the Sammamish River. Despite this classification, Brazilian elodea part of the focus of this management plan and needs to be controlled in the river because dense mats of the submerged plant are already forming and there is risk of further habitat loss for endangered species act (ESA) listed salmonid species. While control of these Class B target weeds has been minimally addressed to date, there is a strong recommendation for these plants to be control within the river system.

Representatives from the municipalities along the river, non-profit groups, concerned citizens, state agencies, and King County Water and Land Resources Division worked together to apply for an Aquatic Weeds Management Fund grant through the Washington Department of Ecology (Ecology) to develop this Integrated Aquatic Vegetation Management Plan (IAVMP).

It is known that many other noxious weeds also occur along the river including, Himalayan blackberry, English ivy, reed canary grass, yellow-flag iris, invasive knotweed, curly leaf pondweed, and Eurasian watermilfoil. These noxious weeds are wide spread and not regulated in King County, but control of them is recommended to ensure the best outcome when restoring the river corridor. This IAVMP will not discuss these non-regulated weeds in detail, but King County Noxious Weed Control Program produced Best Management Practices (BMPs) documents for these weeds which are included as an appendix (Appendix A). These BMPs will help guide any groups or municipalities working on the river on how best to deal with the unregulated noxious weeds.

This Integrated Aquatic Vegetation Management Plan (IAVMP) is a planning document developed to ensure that the applicant and stakeholders have considered the best available information about the waterbody and watershed prior to initiating control efforts. Members of King County Water and Land Resources staff, bordering municipalities, Washington State agencies, river front property owners, and non-profits worked in partnership to develop this IAVMP for the Sammamish River. A core group of stakeholders, along with several King County Staff, formed an IAVMP Steering Committee to address the task of generating community appreciation of and action towards this important ecological, aesthetic and recreational goal. The Committee was able to educate others about the problem, contribute feedback about different treatment options, and work together to decide how best to manage the Sammamish River noxious weed problem.

This IAVMP presents an overview of the aquatic weed problems, details about the planning process, watershed and river characteristics, a review of suitable control options, a management plan, budget and funding plans, and an implementation plan. There is also a large Appendix section that contains background and supporting documents.

LOCATION

The Sammamish River watershed is located in northwest King County (about 70% of total acreage) and southwest Snohomish County (about 30% of total acreage), Washington (Figure 1). Included in the watershed are all or portions of the incorporated cites of: Everett, Mill Creek, Lynnwood, Mountlake Terrace, Brier, Kenmore, Bothell, Woodinville, Redmond, Bellevue, Sammamish, and Issaquah as well as unincorporated portions of King and Snohomish County. The watershed is composed of approximately 153,600 acres that includes 62,080 acres in the Lake Sammamish basin, 32,000 acres in the Bear Creek basin, and 42,880 acres that are the combined Little Bear, Swamp, and North Creek basins. The remaining 16,640 acres comprise the Sammamish River subbasin. In addition to Lake Sammamish and its tributaries, major streams inputs in the river include Bear Creek, Little Bear Creek, North Creek, and Swamp Creek.

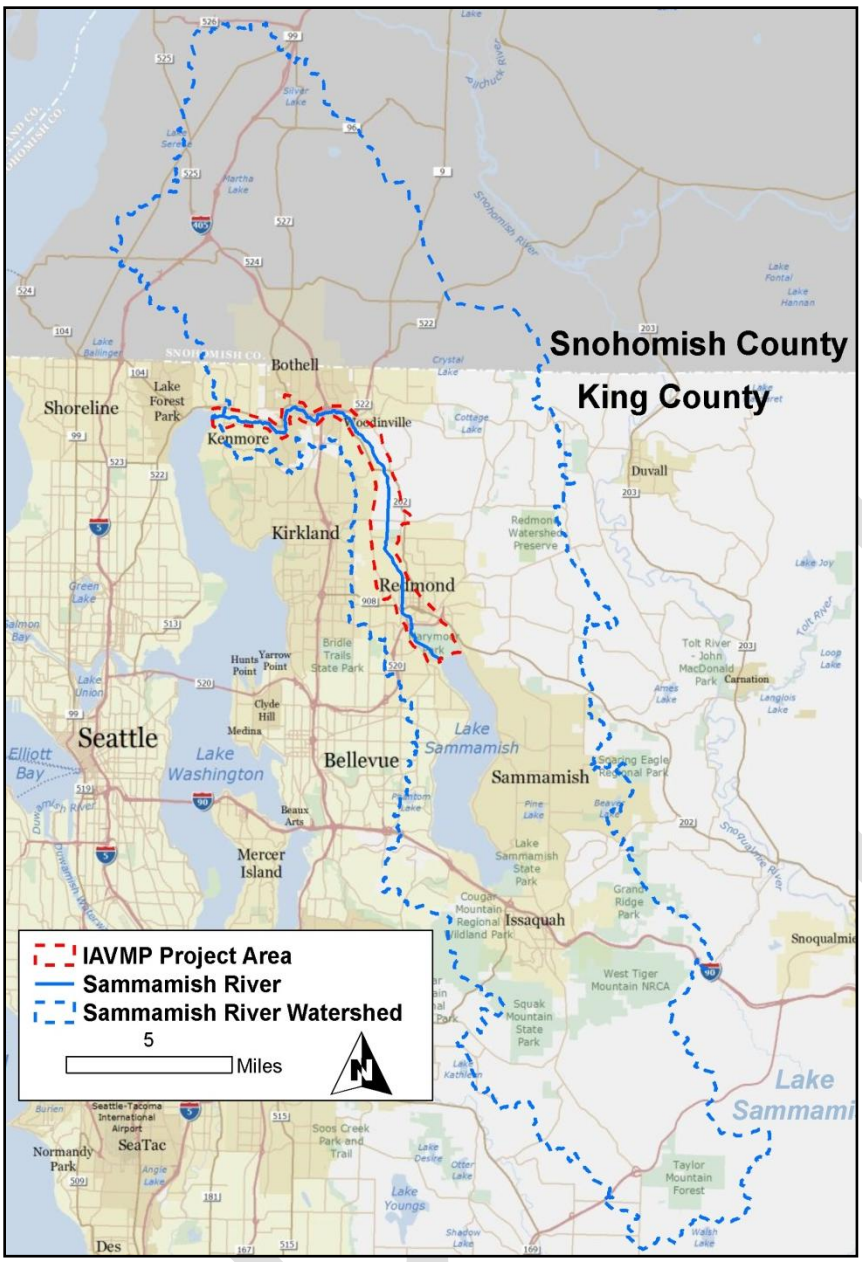

Figure 1. Sammamish River Watershed and IAVMP Project Area Regional Map (King County GIS Center, 2006).

State resource agencies frequently use a system of Water Resource Inventory Areas (WRIA) to refer to the state's major watershed basins. The Sammamish River is located in WRIA 8, which refers to the Cedar-Sammamish combination watershed and includes Lake Washington, Lake Sammamish, and the Cedar River. From the termination of the Sammamish River, it is another 15 miles through the Lake Washington-Lake Union water body to the Puget Sound via the United States Army Corps of Engineers (USACE) Hiram M. Chittenden Locks. The Sammamish River contributes approximately 27 percent of the surface flow to Lake Washington (Kerwin, 2001).

The IAVMP Project Area, as outlined in Figure 1 and other subsequent maps, focuses on the Sammamish River corridor, including the valley floor and the lower extent of tributaries as they enter the River. This project area is 5,373 acres.

PROBLEM STATEMENT

Due to the presence of several species of invasive aquatic noxious weeds, the Sammamish River is in danger of losing aesthetic beauty, wildlife habitat, and recreational benefits which it provides. If left unmanaged , Brazilian elodea could blanket the river in a short time, limiting many recreational uses and eliminating important aquatic habitat. Invasive shoreline plants threaten to turn the shoreline habitat of the Sammamish River into monoculture stands, reducing the suitability of wildlife habitat that the native plants provide.

There are many types of invasive weeds present in the system but this plan will focus on the three Class B regulated aquatic shoreline weeds and the one highly invasive but Class B submerged weed. The goal will be to control and manage the weeds to decrease the threat to the river system. These four weeds are *Lysimachia vulgaris* (garden loosestrife), *Lythrum salicaria* (purple loosestrife), *Phragmites australis* (phragmites, common reed) and *Egeria densa* (Brazilian elodea).
These invasive plants:

- Pose a safety hazard to boaters by entanglement of boating equipment;
- Crowd out native plants, creating monocultures lacking in biodiversity;
- Decrease water quality by affecting temperatures and dissolved oxygen,
- Significantly reduce fish and wildlife habitat, which will potentially degrade fish and wildlife populations;
- Reduce wildlife viewing opportunities;
- Pose a threat to adjoining ecosystems.

Brazilian elodea is the most significant invasive threat to the waterway, but other noxious weeds have been identified in the Sammamish River. Purple and garden loosestrife and common reed have populations along the shoreline that will spread rapidly and out-compete native plants, damaging the ecological functions of the surrounding habitat.

At this point, it will be impossible to discuss the possibility of eradication for the four weeds because of the seed source found upstream in Lake Sammamish. All of the shoreline plants, except for phragmites, have extensive populations in Lake Sammamish, meaning there will be a constant source for reinfestation in the Sammamish River. The same is true for the Brazilian elodea. However, control of the noxious weeds on the river is important to halt and minimize the impacts they have on the river and in order to start the work, it is important to tackle these four weeds first and then through the experiences and successes of this effort, work with shoreline municipalities, non-profit organizations and citizens on continuing the effort of control by working on the non-regulated noxious weeds and restoring the native plant populations in and around the river.

MANAGEMENT GOALS

The goal for this IAVMP is to begin control efforts of the regulated aquatic noxious weeds in and along the Sammamish River in a manner that increases the ability for native plant and animal communities to thrive, maintains acceptable water quality conditions, and facilitates recreational enjoyment of the river.

The following objectives will be pursued to ensure success in meeting this goal:

- Control of the submerged aquatic noxious weed Brazilian elodea to reduce existing populations below the level of significant impact.
- Control of regulated shoreline noxious weeds to reduce existing populations below the level of significant impact and to prevent spread.
- Maintain safe conditions for native salmonids during weed control efforts.
- Involve the Sammamish River community in planning and implementation of the IAVMP.

Detailed treatment prescriptions for each of the noxious weeds that encompass these management goals are covered in subsequent sections of this plan.

COMMUNITY INVOLVEMENT

Steering Committee, outreach, and education process

The King County Department of Natural and Resources and Parks (DNRP) has taken the lead on the IAVMP process for the Sammamish River. In 2010, the King County Noxious Weed Program applied for and received a grant from the Department of Ecology to work with the Sammamish River Community and write the IAVMP for the three Class B regulated weeds and Brazilian elodea which are invasive weed threats in the system.

In spring of 2011, the first steering committee meeting was held at King County where the IAVMP document and process was discussed at length. Thirteen people attended this meeting as a kick off to the project. Attendees included shoreline property owners, local municipal representatives, King County representatives, and WA State agency personnel.

During the remainder of 2011 and the first half of 2012 very little community involvement was done due to project administrative changes. In mid-June 2012 the project was assigned a new project manager and the project has been on track since.

June 2012: Steering Committee Meeting
A meeting was held with 5 attendees that discussed the new project administration and the next steps. A timeline and outline of the IAVMP was discussed

January 2013: Steering Committee Meeting
A third steering committee meeting was held at the end of January 2013. At this meeting, stakeholders discussed the first part of the IAVMP for feedback. The upcoming meeting schedule and the summer surveying/field work schedule were presented.

April 2013: Steering Committee Meeting
At this meeting the second part of the IAVMP, Management Options, was discussed at length

Continuing Community Education

To ensure that the efforts are consistent with best available science and water quality standards, information will be disseminated through bordering jurisdictions, non-profits that work in and on the

river as well as the WRIA 8 Ecological Forum. Watershed mailings can be used when applicable. The steering committee will be able to act as a liaison between community members and groups, jurisdictions and King County DNRP.

WATERSHED AND WATERBODY CHARACTERISTICS

The Sammamish River connects Lake Sammamish to Lake Washington. The basin drains a 240 square mile watershed comprised of the Sammamish River, Bear Creek, Little Bear, Swamp Creek, and North Creek basins (Figures 1, 4).

History of the River

Historically, the Sammamish River was somewhat longer than it is today with abundant "swampy" areas that were filled with peat and diatomaceous earth. Before development the river was approximately 30 miles long and had an even gentler gradient than today (Chrzastowski, 1983). The river corridor was heavily logged from the 1870s through the early 20th century. Throughout the 20th century, the river went through dramatic changes that reduced the complexity of the floodplain including the lowering of the Lake Washington, the channelization of the river, and the construction of drainage ditches in the river valley. The elevation of Lake Washington was lowered about nine feet with the opening of the Chittenden Locks in 1916, and this elevation change drained much of the swampy Sammamish River corridor. In 1911, farmers in the Sammamish River Valley formed a drainage district that began to straighten, widen, and deepen the upper reach of the river from about NE Redmond Way north. In 1962, The Corps of Engineers began to systematically dredge the river, primarily as a flood control project, thus deepening the river 5 feet throughout most of its length, dramatically decreasing its remaining connection with the floodplain. Through this work the Corps hardened much of the upper part of the river's banks. This action resulted in most of the smaller tributaries being cut off from the river. The Corps' project also included the construction of a weir at the Lake Sammamish outlet to help with flood control and maintain water levels. Overall, this project practically eliminated flooding in the Sammamish River valley and reduced the maximum flood elevations and seasonal water surface elevations in Lake Sammamish (King County WLRD, 2012a).

A new weir was installed on the Sammamish River (at river mile 13.24 on the King County river mile designation system) at the outlet of the Lake Sammamish in Marymoor Park in 1998 (Figure 2) (Armburst *et al.*, 2008). The intent of the new weir was, in addition to regulating the level of Lake Sammamish, to "improve fish passage and create a riparian corridor of native vegetation" (2008). No obvious barriers to fish passage were found during a 2002 survey (2008). However, a seasonal thermal barrier (water temperatures potentially uncomfortably warm for some fish) exists between Lake Sammamish and Bear Creek. This is due to the relatively warm water coming from the sun-warmed surface water of Lake Sammamish. At Bear Creek, approximately 1.5 miles downstream of Lake Sammamish, the river receives an input of cooler water (USAC & KC, 2002).

The Sammamish River is now about 13.5 miles long and varies in width from 50-75 feet wide (in the Redmond and Woodinville areas) to about 100 feet wide (in Bothell and Kenmore) to over 200 feet wide near Lake Washington. The upper river corridor extends from Lake Sammamish (about 3,000 feet upstream of the weir) to the city of Woodinville through a floodplain valley that is more than a mile wide in places. Land use in this upper reach includes open space and recreational areas at Marymoor Park, urban commercial and residential development in the city of Redmond, the Willows Run Golf

Course, the Sammamish Valley Agricultural Production District and urban development again in the city of Woodinville. The lower reach extends from Woodinville to the mouth of the river at Lake Washington. This reach has a much narrower drainage area, which includes the downtown cores of Bothell and Kenmore but also open space areas, including the Wayne and Inglemoor Country Club golf courses, Bothell parkland along the Sammamish River Trail, and King County-owned parcels at the mouth of Swamp Creek and the mouth of the river. The WDFW Kenmore Boat Launch facilitates trailer motor boat access to the Sammamish River (Figure 2). From the boat launch, motor boats can navigate upstream as far as the shallow riffle in the waterway just downstream of the junction with Little Bear Creek (at the border between Bothell and Woodinville).

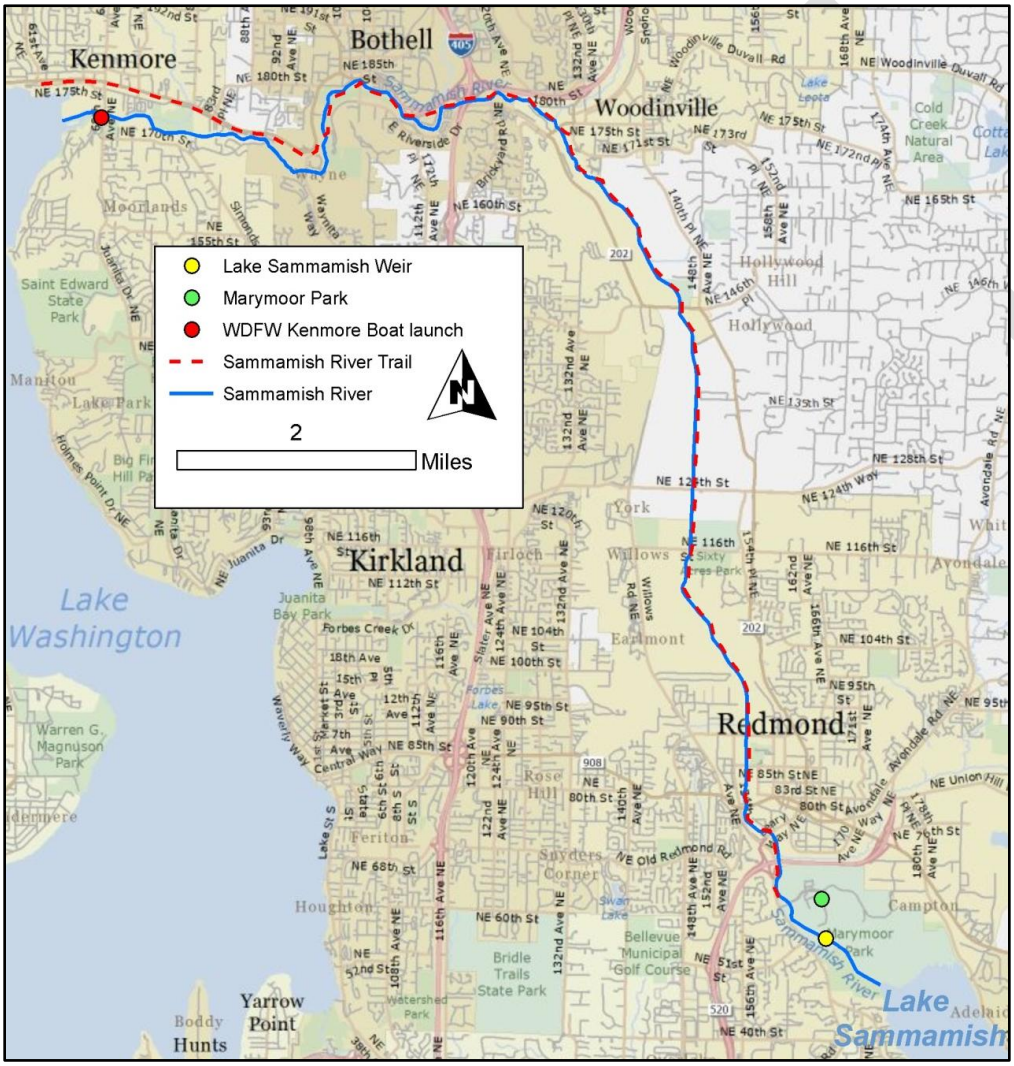

Figure 2. Sammamish River detail.

Land Use Activities in the Watershed and Potential Nonpoint Nutrient Source Locations

The major use within the Sammamish River IAVMP Project Area is residential (Table 1) (Figure 3). The 62% portion of the watershed that is used for residential developments vary from high density multi-family units to 2.5-acre rural lots. The majority of the agriculture in the watershed, approximately 1,450 acres, is concentrated in the Sammamish River 100-year floodplain.

Table 1. Land Use Within the Sammamish River IAVMP Project Area (King County GIS Center, 2007).

Land cover type	acres	% area
cultivated	823	15
mix forest/trees	761	14
grass/herbaceous	1076	20
shrub	109	2
high density development	1608	30
medium density development	722	13
low density development	82	2
water	191	4
total	5372	100

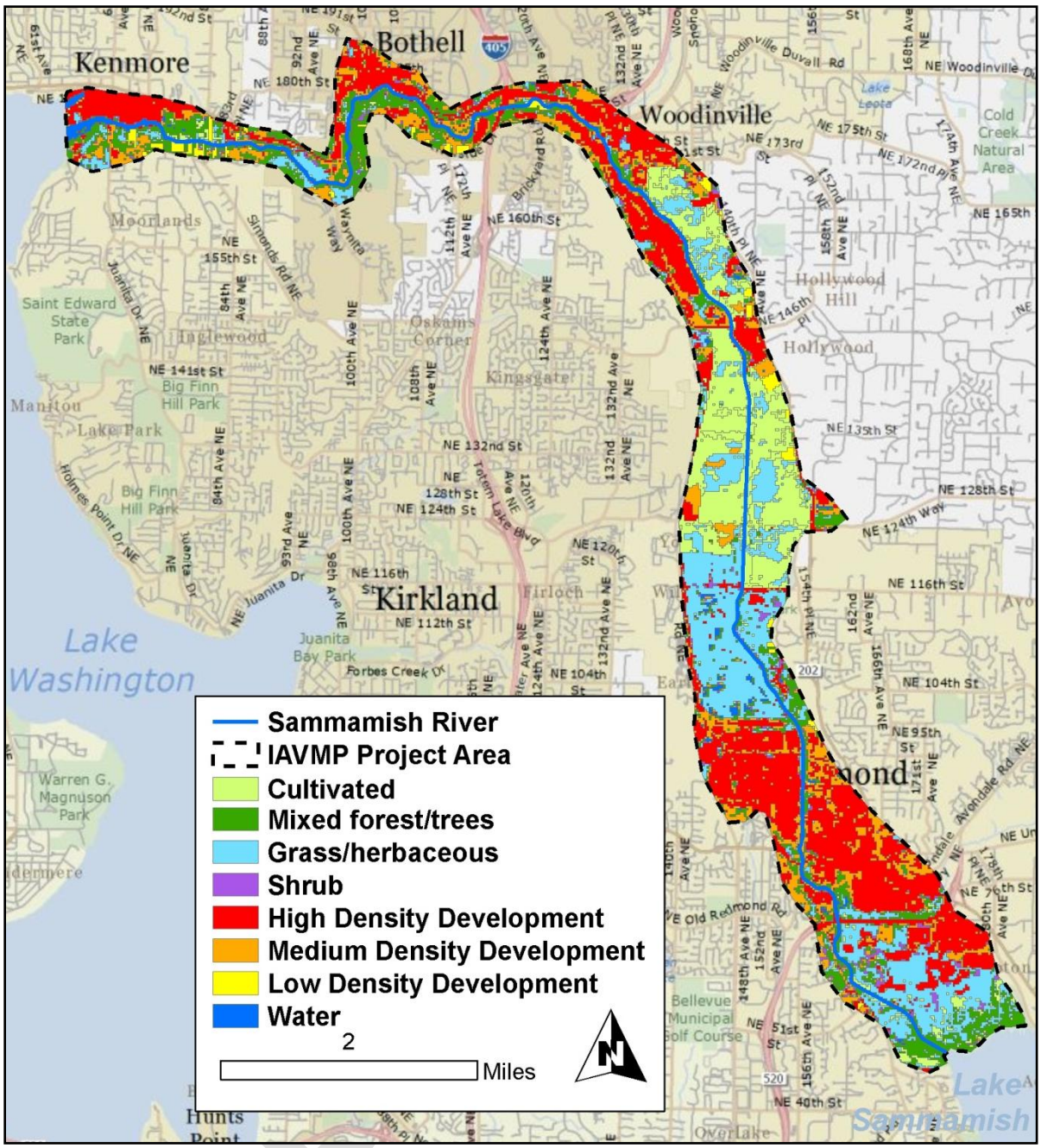

Figure 3. Land use in the Sammamish River IAVMP Project Area (King County GIS Center, 2007).

Stream and Wetland Locations

There are 144 miles of level 1 streams in the Sammamish River watershed (King County GIS Center 2012) (Figure 4). These are streams and rivers that are designated "shorelines of the state" as defined in 90.58.030 RCW. Within the Sammamish River watershed there are 1135 acres of wetlands (King County GIS Center 2005). Most of this wetland area is scattered throughout the watershed, well away from the river's influence. However, 81 acres of wetland are at the origin of the Sammamish River near Lake

Sammamish and 13.5 acres of wetland are at the river's termination at Lake Washington (2005). The remainder of the river is channelized and has no wetlands associated with it.

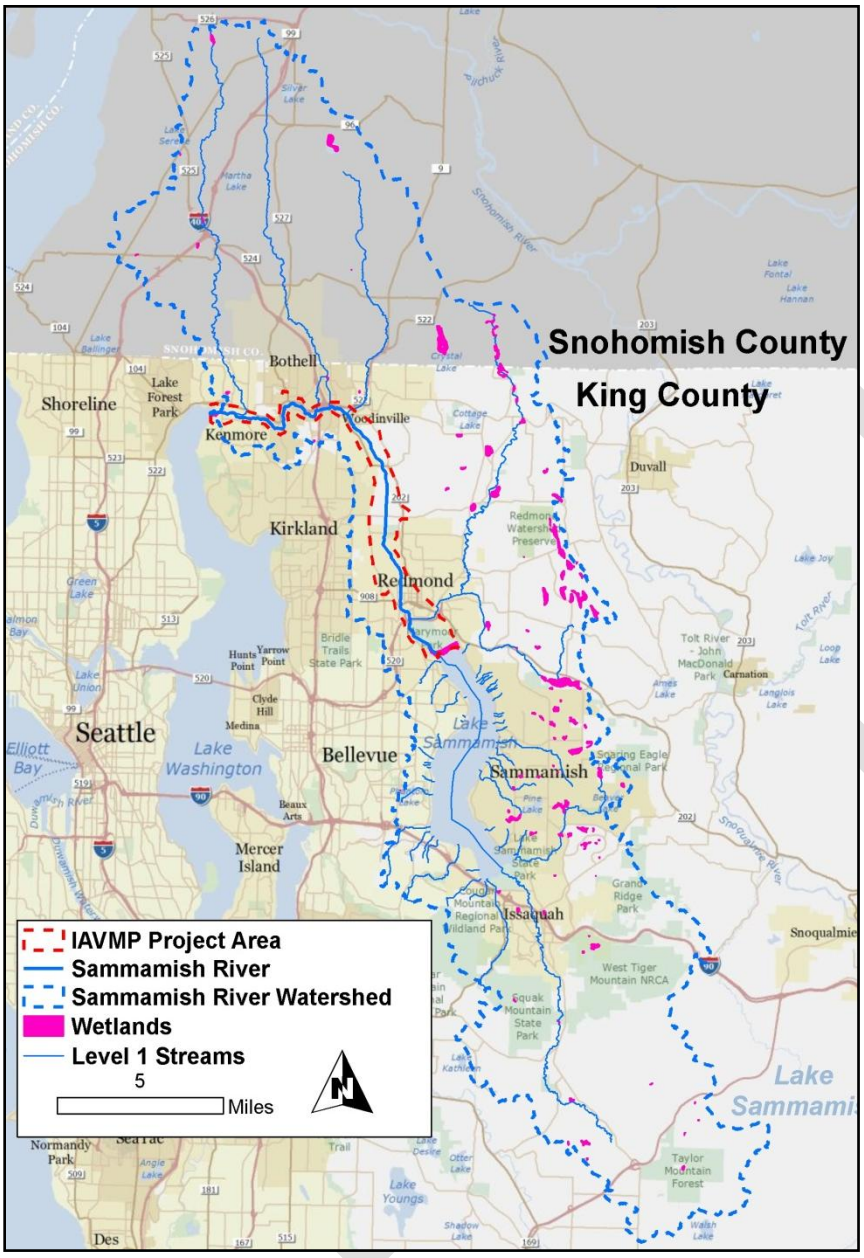

Figure 4. Sammamish River Watershed, Level 1 Stream, and Wetland Map(King County GIS Center, 2005, 2012).

River Flows

The annual average flow rate of the Sammamish River (as measured at the Woodinville USGS gauge # 12125200 from 1965-2000) is 311 cubic feet per second (cfs) (Carey, 2003). The lowest regular flows of 70-75 cfs usually occur in August. Common high flows in the winter range from 500 to 1,550 cfs

(values from stream gauge 51T located at the 116th St NE bridge in Redmond for water years 2005-2013)(King County WLRD, 2013).

Extreme flows on the river (100- year highs and lows) range from about 10 cfs to over 4,000 cfs (USAC & KC, 2002). Most of the river's water flow comes from the surface waters of Lake Sammamish, Bear Creek, Little Bear Creek, Swamp Creek, and North Creek (Figure 4). Additionally, ground water inputs into the river provide a cooling influence to the River's water temperature, especially during the warm summer months (Carey, 2003).

Starting at an elevation of 29 feet at the Lake Sammamish weir (NGVD 29), the Sammamish River drops 14 to 16 feet of elevation over its 13.5-mile-length (King County, 2012b). The elevation of Lake Washington, controlled by the USAC Locks in Ballard, varies from a low of 13 feet (NGVD 29) in the winter months (November-March) to a high of 15 feet (NGVD 29) in the summer (USAC & KC, 2002). Most of this drop occurs within the transition zone as the river begins at Lake Sammamish. In this corridor (including the weir) the river drops 7 feet in about 1450 feet of length (0.47%) (King County, 2012b). The remaining stretch of the river, from the north end of Marymoor Park to Lake Washington, has a very low gradient (0.0195), dropping 7-9 feet in 13 miles (2012b).

Water Quality of the Water Body

Water quality samples are analyzed monthly for temperature, dissolved oxygen, pH, conductivity, turbidity, total suspended solids, ortho-phosphate, total phosphorus, ammonia, nitrate-nitrogen, total nitrogen, and fecal coliform bacteria. Results are compared to State water quality standards. Water quality standards are designed to protect public health and aquatic life. Comparing monitoring results to water quality standards allows an understanding of how safe the river is for recreational contact as well as for aquatic life (King County WLRD, 2012a).

The Sammamish River is categorized as "Core Salmon Migration and Rearing Habitat" for aquatic life use and "Primary Contact" for recreational use. The river is on the 2004 Washington Department of Ecology's (Ecology) 303(d) list for violation of fecal coliform, dissolved oxygen and water temperature standards. Noxious weeds, in particular the Brazilian elodea can exacerbate the temperature and dissolved oxygen issues in the river. It can do this by first inhibiting the water mixing in areas where it grows, and then directly as oxygen is consumed by bacteria during decomposition of dead plant material. Further, dense mats of the elodea can increase water temperature by absorbing sunlight, raise the pH of the water, and exacerbate mosquito breeding areas due to pool creation (KCNWCP, 2010a). Shade producing vegetation along the shoreline can also affect river water temperatures by lessening further warming of the already warm water coming from Lake Sammamish in the summer. The combination of Brazilian elodea and lack of shade producing vegetation along stretches of the river potentially result in a further increase in water temperature.

Status on the 303 (d) list

When assessing water quality the Washington Department of Ecology (Ecology) categorizes waterbody impairments into five categories, ranging from "Category 1" (meets test standards for clean waters) to "Category 5" (polluted waters that require a TMDL). During the 2008 Ecology water quality assessment for the 303(d) list several parameters were found to be "Category 5" in locations throughout the length of the Sammamish River (see Appendix C for table) (WADOE, 2008). "Category 5" water quality test results occur when data shows that water quality standards have been violated for one or more

pollutant and there is no pollution (TMDL) control plan. Parameters for which a "Category 5" rating was recorded on the Sammamish River were: temperature, dissolved oxygen, and fecal coliform. The 2008 assessment of the Sammamish River also found several "Category 2" water quality test results for temperature, which indicate "waters of concern."

Long-term Trends

A 28-year (1979 – 2007) trend analysis was conducted with water quality data from both Sammamish River stations. Results indicated that water quality might have declined over this 28-year period with significant increases in water temperatures and conductivity, and decreasing dissolved oxygen concentrations (King County WLRD, 2012a). High conductivity can suggest the presence of unidentified dissolved charged substances in the water. Water at the mouth of the river is becoming less acidic as indicated by the significant increase in pH (the pH remains within acceptable range relative to the state standards). Decreased total suspended solids (TSS), turbidity, nutrients (ortho-phosphate and total phosphorus, ammonia and total nitrogen), and bacteria levels indicate some improvements in water quality in the same 28-year period.

Problem Algae

The nutrient, light, temperature, and flow characteristics of the Sammamish River support the growth of filamentous green algae in several locations. Filamentous green algae is not toxic, but is considered to be a nuisance when it builds up. (Sally Abella, personal communication: 12-4-12).

Soils

The Sammamish River IAVMP Project Area consists of several dozen soil types, as it covers such a large area. Soil texture can influence the susceptibility of the river bank to erode. Soil texture also influence land managers' choices about what and where vegetation is planted in restoration areas While the historic (before channelization) orientation and elevation of the river may have included more wetland soil types (muck soils), currently the majority of the river corridor's soil types are variations of silty or sandy loam (Table 2, Figure 5) (USDA, 1973).

Table 2. Soil types of the Sammamish River IAVMP Project Area

Soil Type	acres	% of total
clay loam	170	3.2
loamy sand	906	16.9
muck	907	16.9
sandy loam	879	16.4
silt loam	2209	41.1
urban land	168	3.1
water	134	2.5
total	5373	100

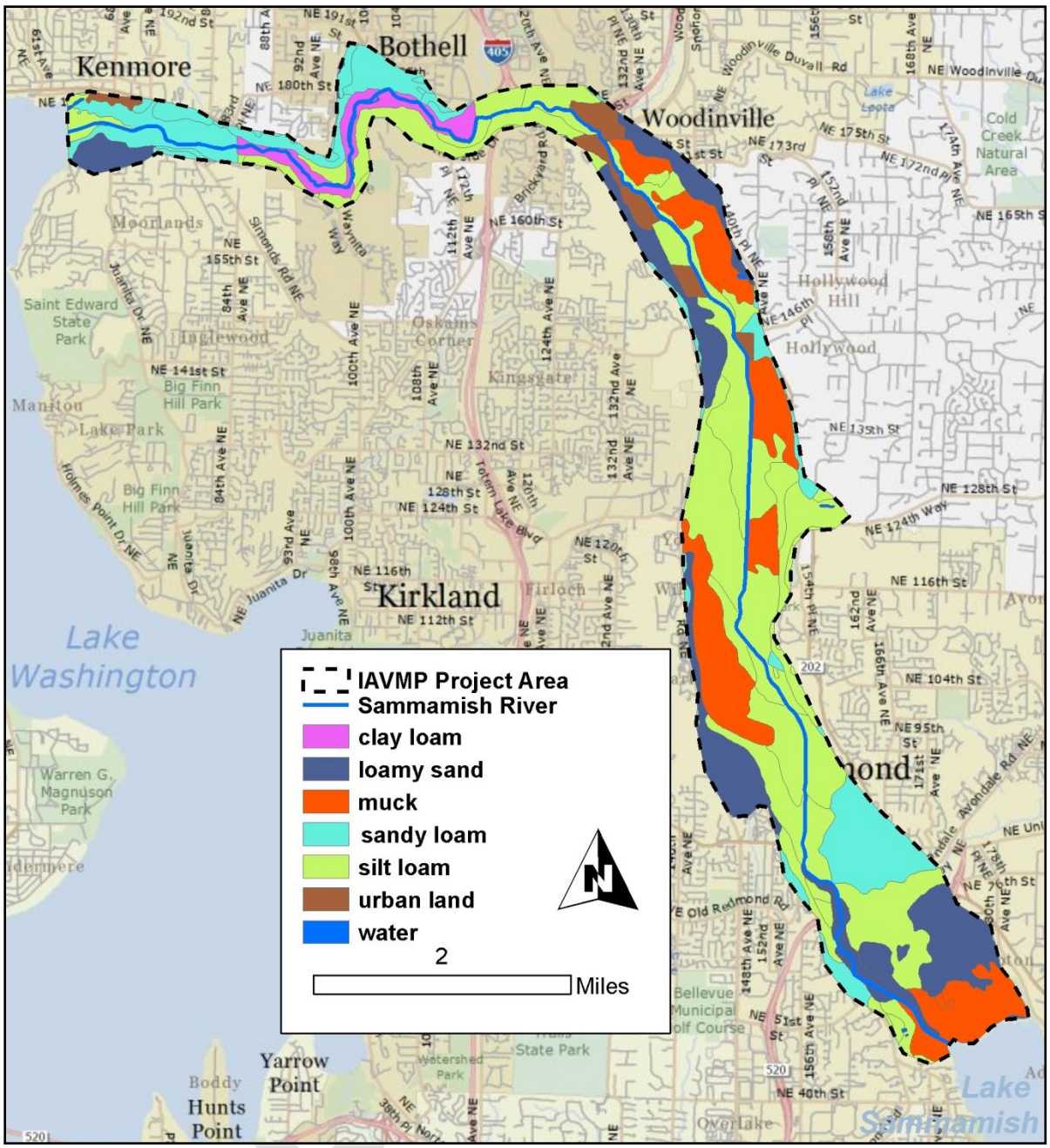

Figure 5. Soil Type of the Sammamish River IAVMP Project Area (USDA NRCS, 1973).

River Sediment and LWD

The very low gradient of the Sammamish River has resulted in slow water flow and a heavily sedimented bottom (WADOE, 1979). Submersed aquatic plants, such as Brazilian elodea which is very well established in large parts of the Sammamish River channel, can exacerbate this by trapping sediment (Madsen *et al*., 2001). Sediments within the Sammamish River channel are primarily silty through the length of the waterbody. Sandy river channel sediments occur at the junctions with Swamp Creek, North Creek, Little Bear Creek, and Bear Creek. The small riffle located just downstream of the junction with Little Bear Creek (about river mile 5.5) also contains a rocky stream bottom for several yards.

There is very little large woody debris in the river channel. This is largely due to removal of trees during channel dredging and straightening as well as a current lack of trees for recruitment along the main or tributary channels (USACE and KC, 2002).

Water Withdrawals

Currently there are 23 certified, active water right withdrawals on the Sammamish River, dating from 1945 to 1977 (WADOE, 2012). Additionally, there are eleven active claims, one active water right application, and ten inactive water rights on the River. Most of the water withdrawal is for irrigation purposes. Combined, the certified, active water rights would allow about ten cubic feet-per-second to be pumped out of the River. The water right withdrawal locations span the length of the River. Municipal wells near the river that affect the aquifer are a further impact to the ground water and, indirectly, the river level.

SHORELINE USE OF THE WATER

The paved Sammamish River regional trail parallels the Sammamish River for about 11 miles, from Marymoor Park in Redmond to Blyth Park in Bothell (Figure 2). From that point, the paved Burke-Gillman regional trail continues west to the outlet of the Sammamish River into Lake Washington. Major parks along the river that have public river access points include Marymoor Park, Wilmont Gateway Park, Bothell Landing Park, Blyth Park, and the WDFW Kenmore Boat Launch (Figure 2), which is popular for shoreline fishing. Marymoor Park also contains a large, 40-acre dog park that includes about 250 feet of free dog access to the river in four locations. The Kenmore Boat Launch provides access to the river just upstream of the mouth to Lake Washington (Figure 2). There are also three golf courses adjacent to river: Willows Run Golf Club, Wayne Public Golf Course, and the Inglewood Golf Club. There are about 1.95 miles of river shore that have at least one side with residential use extending clear to the water's edge.

BENEFICIAL AND RECREATIONAL USES

Recreation on the river is mainly limited to boating, both for general recreation and fishing. Fishing is popular in the backwater part of the river near Lake Washington as accessed by the Kenmore WDFW boat launch (Figure 2). Canoeing, rowing, and kayaking are popular the length of the river. Other kayaking activities on the river include past hosting of the 12-mile kayak leg of the Mountains to Sound Relay and a Kayak Rental outfitter in Bothell.

Through 1976 a motor boat race called the Sammamish Slough Race was held on the River (Redmond Historical Society, 2012). However, nowadays motor boats are usually only found downstream of the riffle near Little Bear Creek to Lake Washington. Some of the residential properties that abut the River in that stretch even have boat docks. The entire Sammamish is a "No Wake" zone for motor boats.

There are no public swimming access points along the river; however there are places where the public can easily access the water at numerous parks along its length. No portion of the river has lifeguards present at any time during the year.

In addition to the Sammamish River Trail and recreation directly in or on the water, other beneficial uses of the river include bird and other wildlife watching. There are several birding organizations that frequent the shores of the Sammamish River including Friends of Marymoor Park and Eastside Audubon.

Fish and Wildlife Communities

The Sammamish River and the surrounding terrestrial habitat in the river corridor support a variety of fish, birds, and animals by providing nesting, forage, and cover.

Fish

Chinook, coho, sockeye, kokanee, steelhead, and coastal cutthroat are known salmonid species to currently inhabit the Sammamish River system (Table 3) (Kerwin 2001). The United States Fish and Wildlife Service have identified the river and its tributaries as potential foraging habitat for bull trout on the assumption that they are found in the watershed. Volunteers with the Salmon Watcher Program have been making observations at various locations within the Sammamish River basin since 1997. In addition to the native salmonid species and the native bull trout, 24 species of introduced have been reported to occur in the Lake Washington Basin (WRIA 8), (Table 3),(Kerwin, 2001).

Two salmon-bearing tributary systems are located in the upper reach: Bear Creek and Little Bear Creek. The lower reach includes two large salmon-bearing tributaries: Swamp Creek and North Creek (Kerwin, 2001).

Table 3. Fish of the Sammamish River (Kerwin, 2001)

American shad*	Cherry salmon*	Lake whitefish*
Atlantic salmon*	**Chinook salmon**	Largemouth bass*
Black bullhead*	**Coho salmon**	Pumpkinseed sunfish*
Black crappie*	Common carp*	Smallmouth bass*
Bluegill*	**Cutthroat trout**	**Steelhead trout**
Brook trout*	Fathead minnow*	Tench*
Brown bullhead*	Goldfish*	Warmouth*
Brown trout*	Grass carp*	Weather loach*
Bull trout	**Kolanee salmon**	White crappie*
Channel catfish*	Lake trout*	Yellow perch*
bold = native fish, * = non-native fish (occurring in WRIA 8)		

Birds

Birds are attracted to the Sammamish River and its surrounding riparian habitat due to the mix of forest, wetland, and open water habitats. Birding enthusiasts along the river and at the origin of the river (Marymoor Park) have been compiling bird occurrence and activity data for several decades. At the river and adjacent wetlands of Marymoor Park, 232 different species of birds have been observed over the past 23 years (Appendix C) (FOMP, 2012). Of these species, 27 are on the Washington State Department of Fish and Wildlife Species of Concern list (Table 4). A separate list of bird sightings has been recorded along the Sammamish River at multiple locations within the Redmond city limits (Roger Dane, personal communication: 11-27-12). From 2008-2012 this survey found a total of 89 species of birds.

Table 4. WDFW Species of Concern bird list seen at Marymoor Park (FOMP, 2012).

WDFW species of concern status: ***State, Federal***	Common Name	if seen only in one year (sole year noted)
SM, none	Ash-throated Flycatcher	2010
SS, Fco	Bald Eagle	multiple years
SM, FCo	Black Swift	multiple years
SM, none	Black Tern	2004
SE, FCo	Brown Pelican	2008
SC, FCo	Burrowing Owl	2008
SM, none	Caspian Tern	multiple years
SS, none	Common Loon	multiple years
SC, none	Golden Eagle	2008 ?
SM, none	Great Blue Heron	multiple years
SM, none	Great Egret	2005
SM, none	Green Heron	multiple years
SC, none	Lewis's Woodpecker	2011
SC, FCo	Loggerhead Shrike	2011
SC, FCo	Northern Goshawk	2000 ?
SM, none	Osprey	multiple years
SS, Fco	Peregrine Falcon	multiple years
SC, none	Pileated Woodpecker	multiple years
SC, none	Purple Martin	multiple years
SM, none	Red-necked Grebe	multiple years
SC, none	Sage Sparrow	2007
SC, none	Sage Thrasher	2007
SE, none	Sandhill Crane	2010
SM, none	Swainson's Hawk	2008
SM, none	Turkey Vulture	multiple years
SC, none	Vaux's Swift	multiple years
SC, none	Western Grebe	multiple years
Status code Key: State- (SE: State Endangered), (SC: State Candidate), (SS: State Sensitive), (SM: State Monitored). Federal- (Fco: Federal Species of Concern)		

Mammals, Reptiles, and Amphibians

A variety of mammals, reptiles, and amphibians utilize the Sammamish River during various times in their live cycle. A list compiled by Michael Hobbs and the Friends of Marymoor Park at Marymoor Park over the past several years demonstrates the range of sightings (Table 5) (FOMP, 2012).

Table 5. Mammals, Reptiles, and Amphibians seen at Marymoor Park (Sammamish River environs) (FOMP, 2012).

Mammals		
Beaver	Black Rat	Black-tailed Jackrabbit
Common Opossum (I)	Coyote	Eastern Cottontail (I)
Eastern Gray Squirrel (I)	Long-tailed Vole	Long-tailed Weasel
Mink	Mountain Beaver	Mule Deer
Muskrat	Northern Flying Squirrel	Raccoon
River Otter	Townsend's Chipmunk	Townsends Mole

Reptiles and Amphibians		
Bull Frog (I)	Northwestern Garter Snake	Pacific Tree Frog
Painted Turtle (I)	Red-eared Slider (I)	

CHARACTERIZATION OF THE AQUATIC PLANTS AND SHORELINE VEGETATION OF THE SAMMAMISH RIVER

Pre-European settlement the floodplain of the Sammamish River was primarily heavily vegetated wetland (USACE & KC, 2002). Native plant communities included emergent wetland, shrub wetland, forested wetland, riparian forest, and upland forest (2002).

The vegetation along and in the Sammamish River has been highly altered since European settlement, and further since being channelized in the 1960s. The existing steep banks that line most of the River and the historic dredged channel both influence what type of plants grow. Now no longer forested, the riparian area of the river only contains scattered mature tree.

There are no known vegetation surveys done specifically of the Sammamish River. However, a detailed plant survey was conducted in Marymoor Park in 2000-2002 (Appendix C). The location of this survey includes both the river corridor and the adjacent wetland and upland habitats. The survey, conducted by Washington Native Plant Society, found a total of 158 species; of which, 71 are native and 87 are introduced. Of the introduced plants, 18 species are on the 2012 King County Noxious Weed List.

Rare Plants

A data search with the Washington State Department of Natural Resources' (DNR) Washington Natural Heritage Program (WNHP) found no know rare plants in the Sammamish River corridor. A letter from DNR stating this is the case is included in Appendix C.

General Shoreline Vegetation

Upland riverbank vegetation along the Sammamish varies from maintained native plant restoration sites to landscaped residential properties to 100% invasive species cover (Table 6, Figure 6). For purposes of this report, "upland" riverbank or shoreline vegetation is considered to be the plants that do not require that "their feet are wet"; i.e., usually Facultative Upland or drier. This swath of vegetation extends from the river's edge up to the top of the hardened banks of the channel. Most of the steep-sloped river bank is covered in vegetation. In November of 2012 a cursory survey of the river's upland shoreline

vegetation was done by the King County Noxious Weed Control Program (KCNWCP). Approximately eleven percent of the shoreline was found to be landscaped and 89% of the shoreline vegetation was "wild", ranging from maintained native plant restoration sites to 100% Himalayan blackberry or reed canarygrass.

Restoration areas seen during this survey ranged from "recently installed" to mature. Sections of the river that had just been restored consisted of dense plantings of young native trees and shrubs with noxious weeds cleared away. Mature restoration areas may consist of a dense thicket of alder or willow or widely spaced cottonwood or conifer. The *"restoration of riparian vegetation"* is one emphasized action to improve migratory and rearing conditions for salmon as proposed in the WRIA 8 Chinook Salmon Conservation Plan (WRIA 8 Steering Committee and Forum, 2005).

Table 6. Noxious Weed Cover along the Sammamish River Shoreline.(KCNWCP 2012)

% noxious weed cover*	Miles of shoreline
0%-20%	2.1
20%-40%	4.6
40%-60%	2.5
60%-80%	0.7
80%-100%	15.5
Total (both banks)	25.4

*the vast majority of this noxious weed cover is comprised of Himalayan blackberry and reed canarygrass

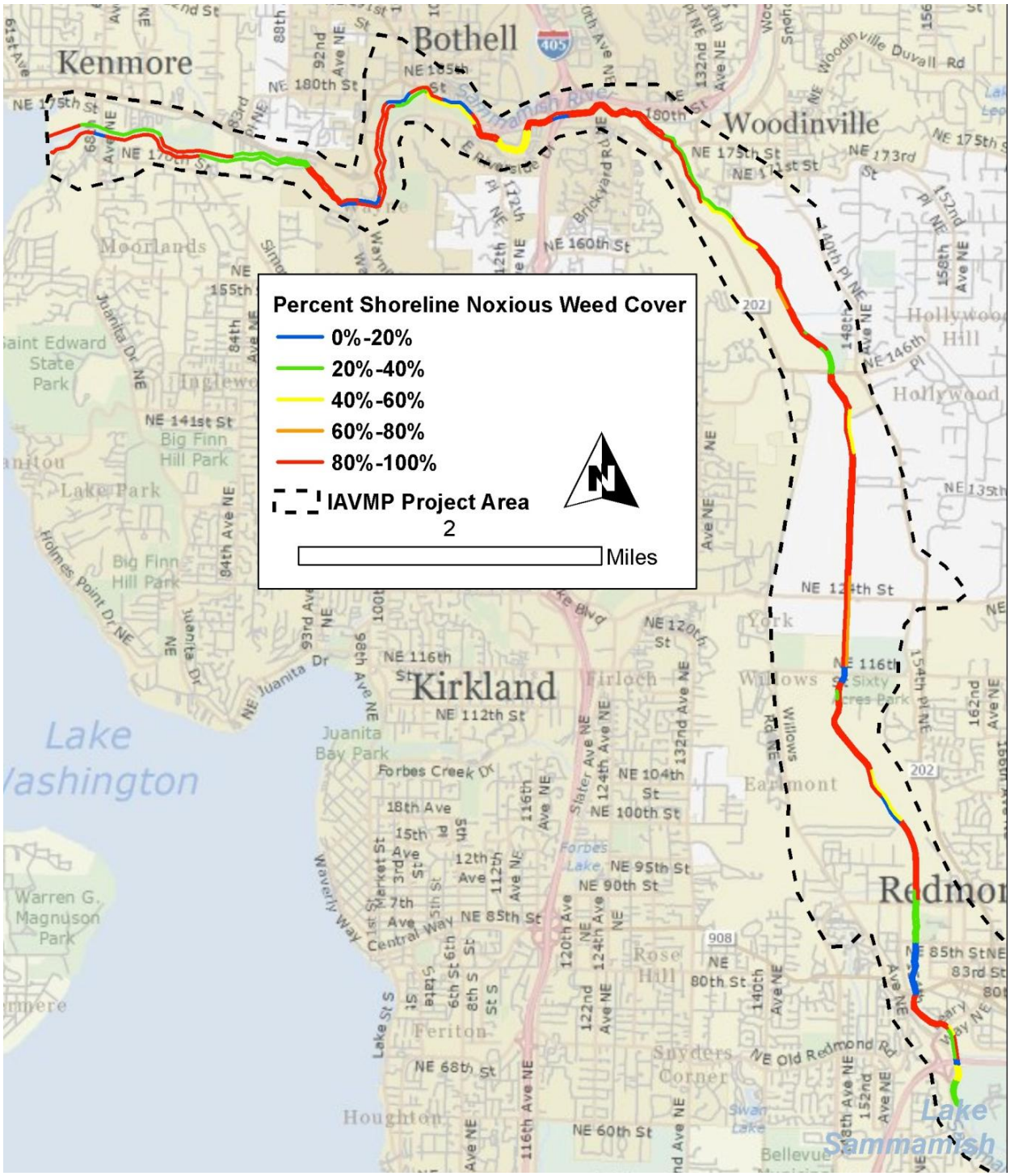

Figure 6: Percent Noxious Weed Cover of the Sammamish River Shoreline Vegetation (KCNWCP, 2012)

During the November 2012 survey, the percent noxious weed cover was estimated for each section of river bank; right and left river banks were surveyed separately (Figure 8).

The vast majority of non-regulated noxious weed present along the Sammamish River are either Himalayan blackberry or reed canarygrass. These two plants are wide spread throughout western

Washington and prevent the natural establishment of woody shoreline vegetation. In addition to blackberry and reed canarygrass, other regulated and non-regulated noxious weeds were found scattered along the upland part of the river bank (Table 7). These sparse to scattered upland weeds include tansy ragwort, English holly, Scotch broom, butterfly bush, common tansy, and poison hemlock. Upland noxious weeds such as these exclude native upland vegetation, alter the activity of native pollinators, and can be poisonous to animals.

Control of all of these unregulated noxious weed species will not be discussed in detail as part of the IAVMP. The Best Management Practices documents produced by the King County Noxious Weed Control Program for these weeds are included as an appendix to this document (Appendix A). These documents will help guide any groups or municipalities working on the river on how best to deal with unregulated noxious weeds.

Table 7. Noxious Weeds on the Sammamish River (KCNWCP, 2013)

Common Name	Scientific Name	Class	Regulated on the Sammamish River	Location	Distribution Along the River	
Brazilian elodea	*Egeria densa*	B	no*	Submersed/ floating	Very wide spread	Regulated in King County
Common reed/phragmites	*Phragmites australis*	B	yes	Shoreline	Sparse	
garden loosestrife	*Lysimachia vulgaris*	B	yes	Shoreline	Very wide spread	
purple loosestrife	*Lythrum salicaria*	B	yes	Shoreline	Very wide spread	
tansy ragwort	*Senecio jacobaea*	B	yes	Upland	Scattered	
butterfly bush	*Buddleia davidii*	B	no	Upland	Scattered	Non-Regulated in King County
common tansy	*Tanacetum vulgare*	C	no	Upland	Sparse	
curly-leaf pondweed	*Potamogeton crispus*	C	no	Submersed/ floating	Sparse	
English holly	*Illex aquifolium*	w.o.c.*	no	Upland	Sparse	
English ivy	*Hedera helix*	C	No	Upland	Scattered	
Eurasian watermilfoil	*Myriophyllum spicatum*	B	no	Submersed/ floating	Scattered	
fragrant water lily	*Nymphaeae odorata*	C	no	Submersed/ floating	Sparse	
Himalayan blackberry	*Rubus armeniacus*	C	no	Upland	Very wide spread	
invasive knotweed	*Polygonum* Sp.	B	no	Upland	Very sparse	
poison-hemlock	*Conium maculatum*	B	no	Upland	Sparse	
reed canarygrass	*Phalaris arundinaceae*	C	no	Upland/ Shoreline	Very wide spread	
Scotch broom	*Cytisus scoparius*	B	no	Upland	Scattered	
yellow flag iris	*Iris pseudacorus*	C	no	Shoreline	Sparse	

*w.o.c. = Weed of Concern in King County- an invasive, non-native plant for which control is recommended.
*Brazilian elodea is regulated in most of King County except for Lake Doloff, Fenwick, Sammamish, Washington, Union, and the Sammamish River due to large established populations in these waterbodies.

FOCUS ON NOXIOUS WEEDS FOR THIS MANAGEMENT PLAN

The term "noxious weed" refers to those non-native plants that are legally defined by Washington State's Noxious Weed Control Law (RCW 17.10) as "highly destructive, competitive, or difficult to control once established." Noxious weeds have usually been introduced accidentally as a contaminant, or as ornamentals. Non-native plants often do not have natural predators (i.e., herbivores, pathogens) or strong competitors to control their numbers as they may have had in their home range. The Washington State Noxious Weed Board has designated purple loosestrife (*Lythrum salicaria*), garden loosestrife (*Lysimachia vulgaris)*, and phragmites/common reed (*Phragmites australis*) as regulated noxious weeds on the Sammamish River, meaning their control and/or eradication is required (Table 7) (WSNWCB, 2013). Brazilian elodea (*Egeria densa*), Eurasian watermilfoil (*Myriophullum spicatum*), fragrant water lily (*Nymphaea odorata*), invasive knotweeds (*Polygonum* spp.), reed canarygrass (*Phalaris arundinacea*), Himalayan blackberry (*Rubus armeniacus*), English ivy (*Hedera helix*), and Yellow flag iris (*Iris pseudacorus*) are listed noxious weeds (Table 7), but their control is not required by the King County Noxious Weed Board because they are already widespread in this part of the county (KCNWCP, 2013). However, Brazilian elodea is addressed in this document as it is the dominant submersed weed in the river system and can negatively impact the salmonid species and associated rearing and spawning habitat. For that reason, control plans will be explored for Brazilian elodea.

Another reason these four plants (purple loosestrife, garden loosestrife, common reed, and Brazilian elodea) are the focus of the management plant to better position the project to receive grant funding from Ecology should it be pursued. Ecology funds Aquatic Weed Management Fund grants which focus on the control of regulated noxious weeds in waterways that have pubic boat access.

NOXIOUS WEED CONTROL HISTORY ON THE SAMMAMISH RIVER

While noxious weeds have been an issue on the Sammamish River for many years, a coordinated control effort has been slow to form. No whole-river efforts have targeted submersed or shoreline noxious weeds on the Sammamish River.

However, many local municipalities along the river have done shoreline restorations and have plans to continue the efforts. The focus of many of these projects is often to improve fish and wildlife habitat as well as aesthetics for the public. For example, the city of Bothell has future restoration planned for areas where two creeks empty into the Sammamish River. These plans include day lighting creeks, channel restoration and riparian plantings. This effort will likely include approximately 5,000 feet of Sammamish River shoreline. Another example is the city of Redmond, which has approximately 15,000 feet of river shoreline restoration planned. These projects include bank regrades, adding habitat features and riparian plantings. These actions will directly benefit the goals of the WRIA 8 Chinook Salmon Conservation Plan which proposes the "restoration of riparian vegetation" as one focus of action to improve migratory and rearing conditions for the fish (WRIA 8 Steering Committee and Forum, 2005).

Restoration efforts along the banks of the Sammamish River should be coordinated to ensure work is not duplicated and progresses in a methodical manner. It is important that as restoration projects (including noxious weed removal and planting) are planned, regulations and guidelines are looked into such as Critical Area Ordinances (CAO's), Shoreline Master Programs, and planned levee setbacks. The

King County Noxious Weed Control program has monitored and worked to achieve control of purple and garden loosestrife along the river for many years (Figures 8 and 10). However, while the plants persist year to year, control enforcement has been variable. This is due to the extremely large amount of the plants, the many agencies (local, county, and state) involved, the lack of a strategy for the whole infestation and that populations continue to exist in Lake Sammamish, which contributes to the Sammamish River infestation.

EMERGENT AQUATIC NOXIOUS WEEDS

Many regulated and non-regulated noxious weeds grow right at the water's edge or in an emergent manner. These plants often crowd out native vegetation by forming dense stands at the water's edge. They dramatically reduce habitat value of shorelines and access to the river. Shoreline aquatic noxious weeds that have been found along the Sammamish River are: yellow flag iris, invasive knotweed species, reed canarygrass, phragmites/common reed, garden loosestrife, and purple loosestrife (Table 7). Some of these are regulated (required to be controlled) and some are not, but they all have an impact on the river.

Regulated emergent aquatic noxious weeds are a higher priority for control and a focus of this Management Plan. The three regulated emergent noxious weeds that occur on the Sammamish River are the Class B noxious weeds purple loosestrife, garden loosestrife, and phragmites/common reed. While phragmites is only found in a few locations along the river, purple loosestrife and garden loosestrife are both wide spread emergent aquatic noxious weeds on the river. A detailed discussion of each of these plants follows.

Lythrum salicaria (purple loosestrife)

Purple loosestrife, a regulated Class B Noxious Weed in King County, was introduced to the United States in the early 1800s at northeastern port cities, in ship ballast obtained from European tidal flats (KCNWCP, 2011). It arrived in marine estuaries in the Pacific Northwest in the early 1900s, suggesting that it was spread by maritime commerce. Deliberate planting and escapes from cultivation likely aided in the spread of infestations across the country. Purple loosestrife was first reported found in Washington in 1929 along the Lake Washington shoreline. Currently purple loosestrife is found around the perimeter of Lake Sammamish and is found on about 80% of the shoreline of the Sammamish River (Figure 8). It is the most common regulated aquatic noxious weed in King County. Control of the plant along the river has been inconsistent over the years.

Purple loosestrife is an invasive and competitive noxious weed that alters wetland ecosystems by replacing native and beneficial plants (KCNWCP, 2011). Water-dependent mammals and waterfowl and other birds leave wetlands when their food source, nesting material and shelter are displaced by the plant. Purple loosestrife occurs in freshwater and brackish wetlands, lake and river shorelines, streams, ditches and wet pastures. It requires partial to full sunlight and moist soil to standing water.

Figure 7. Purple loosestrife.

Purple Loosestrife is a perennial emergent aquatic plant that can reach over 9 feet tall and 5 feet wide (Figure 7) (KCNWCP, 2011). As many as 30 herbaceous stems emerge from the persistent taproot and spreading roots. The plant is noted for its square (sometimes six-sided) stem and opposite leaves. Purple loosestrife's showy magenta flowers appear from July into October. Reproduction is mainly by seed but also by stem and root fragment. A mature plant can produce over two million pepper-sized seeds per year. The seeds, which can remain viable for about three years, are dispersed mainly by water but also by animals, boots, tires, boats, and pets. Mature plants can live for 20 years.

The original mechanism for purple loosestrife infestation on the Sammamish River is not known but likely occurred through a combination of several sources (upstream waterways, unintentional plant part or seed transfer by humans, intentional ornamental plantings, transfer by animal feathers or fur, and possibly wind). Most notably, immediately upstream of the Sammamish River, the shoreline of Lake Sammamish is ringed by uncontrolled purple loosestrife plants growing largely in residential waterfronts.

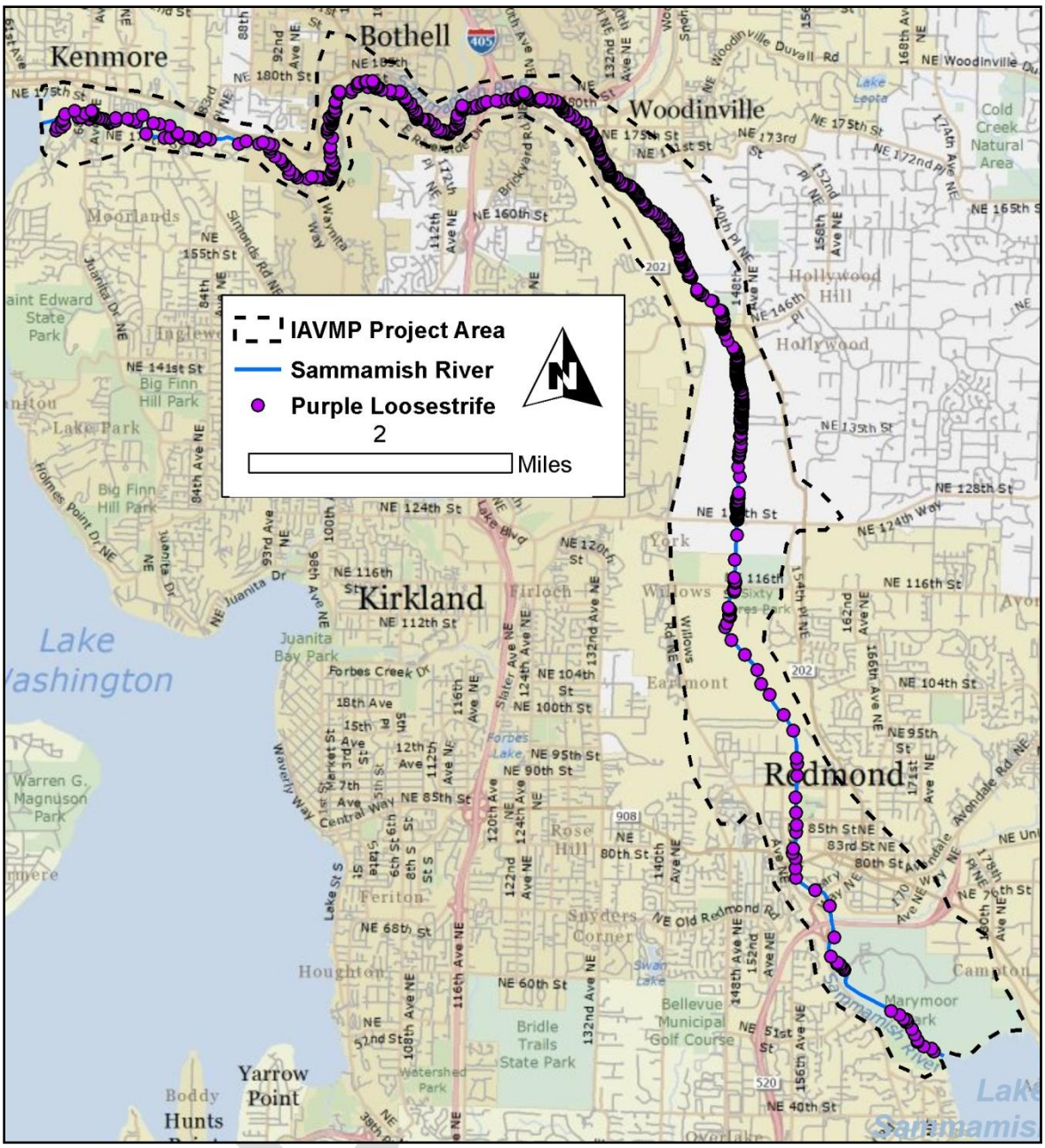

Figure 8. Purple loosestrife locations in the IAVMP Project Area.

Lysimachia vulgaris (garden loosestrife)

Garden loosestrife, a regulated Class B Noxious Weed in King County, is native to Europe and Asia and was introduced to North America as an escaped garden ornamental (KCNWCP, 2010b). In Washington, the earliest record is a herbarium specimen from Juanita Bay in Lake Washington dated 1978. However, the extent of the infestation on the shoreline of Lake Sammamish suggests that the actual introduction was considerably earlier. Uncontrolled garden loosestrife plants are commonly found in residential waterfronts all around the lake.

Figure 9. Garden loosestrife.

Garden loosestrife is a perennial that can reach 10 feet tall in the shade (generally 4-7 feet tall in full sun) (Figure 9) (KCNWCP, 2010b). Yellow 5-petalled flowers with orange centers are borne in terminal panicles with smaller clusters on stalks from the upper leaf nodes. Stems and leaves are slightly fuzzy, and leaves are opposite or in whorls of three (sometimes four). Garden loosestrife is considered a facultative wetland species, usually occurring in wetlands but occasionally found in uplands. These plants produce seed in dry capsules, and a large plant can produce 100 or more seeds. A recent study at the University of Washington found nearly 90% germination success. Seed longevity is not precisely known, but seeds can remain viable for at least several years. Seeds ripen in late fall or early winter (usually November in King County). Garden loosestrife also reproduced through vegetative means, either by rooting at nodes on the stem or by fragmentation of stolons and rhizomes. Vegetative reproduction seems to be common in King County. Red stolons can reach 15 feet long and branch in the fall before fragmenting. Garden loosestrife can tolerate fairly deep shade.

Similar to the unrelated but more widespread purple loosestrife, garden loosestrife disrupts wetland ecosystems by displacing native or beneficial plants (KCNWCP, 2010b). Loss of native vegetation results in decreased sources of food, nesting material, and shelter. Economic impacts could be high in agricultural communities when irrigation systems are clogged or when wet pastures are turned into a monoculture and are unavailable for grazing.

Garden loosestrife is aggressive and competitive, taking full advantage of disturbance to natural wetland vegetation caused by anthropogenic alterations of the landscape. It has been observed to outcompete and displace other aggressive species, including purple loosestrife and cattails (KCNWCP, 2010b).

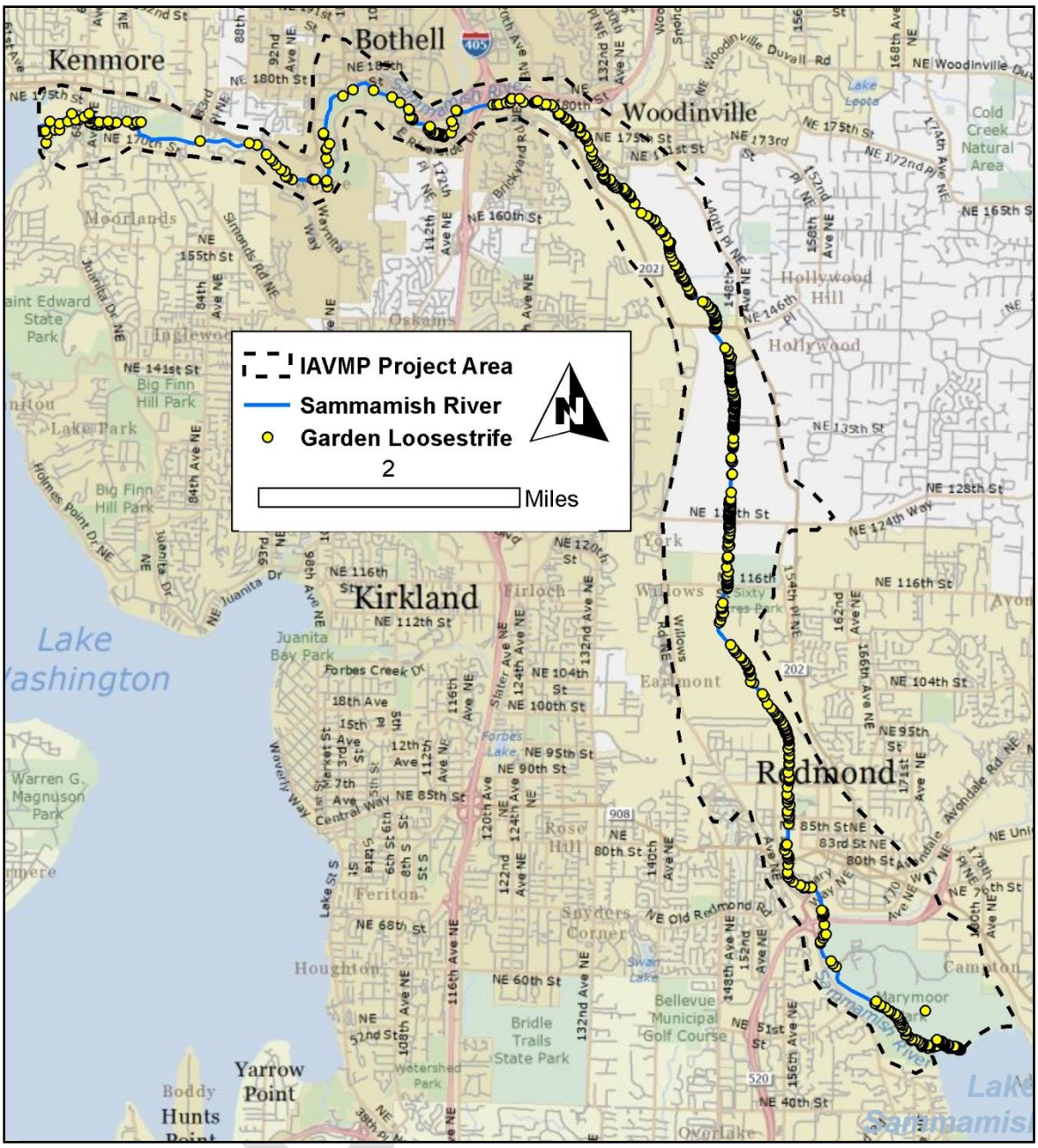

Figure 10. Garden loosestrife locations in the IAVMP Project Area.

Garden loosestrife is found growing on the lower parts of both banks of the Sammamish River all the way from Lake Sammamish to Lake Washington (Figure 10). It covers 40% of the shoreline of Lake Sammamish and is established in most of the wetlands on Lake Washington and along the shoreline wherever there is available habitat (primarily public parks). Currently there are aggressive grant-funded efforts to control garden loosestrife in Lake Sammamish State Park, Marymoor Park and Union Bay. In addition, the cities of Issaquah, Bellevue, Redmond, Kenmore, Kirkland, Seattle, Mercer Island and Renton have an ongoing commitment to maintain control of this plant on public shorelines on Lakes Sammamish and Washington. There has not yet been a coordinated effort to gain control of the garden loosestrife along the Sammamish River. Seeds and plant fragments from uncontrolled populations on

the Sammamish River migrate downstream and can re-infest areas in Lake Washington where the weed has been controlled or not yet established.

Phragmites australis (phragmites, common reed)

The species *Phragmites australis*, a regulated Class B Noxious Weed in King County, has inhabited wetlands in North America for over 3,000 years. However, recent research has shown that in the late 19th century, several European strains (haplotypes or genotypes) were introduced and had a competitive advantage over native strains as well as other native species (KCNWCP, 2010c). The introduced strains now have a widespread distribution in the United States and can be found in every state. The invasive strains of phragmites create tall dense stands that degrade wetlands and coastal areas by competing with native vegetation (including the native phragmites) for space and resources, creating a monoculture. Both the native and non-native strains are present in Washington State, although no populations of the native strain have been recorded in King County (KCNWCP, 2010c). However, positive identification should be sought prior to controlling any phragmites population. Identification can be difficult. Any previously unknown phragmites should be reported to the KCNWCP for identification assistance.

Figure 11. Phragmites, common reed.

Phragmites is a tall, clonal, long-lived grass which lives in wetlands, and lake and stream margins (Figure 11). It can tolerate brackish water and is often found in estuaries and tidal wetlands. It is considered a facultative wetland species, usually occurring in wetlands but occasionally found in uplands. It has tan woody stems to 12 feet tall and feathery, plume-like flower heads that are purplish at first and turn tan as they mature. Stiff, gray-green leaves are up to 16 inches long and 1.5 inches wide. Phragmites can spread by seed, but most commonly it spreads laterally on rhizomes (underground stems) or from root fragments. Rhizomes can exceed 60 feet in length, grow more than six feet per

year, and readily grow into new plants when fragmented. The roots form a dense mat that can reach a depth of up to six feet. Stands of the native strain have lower stem density, less dense flower heads, slightly different coloration and more flexible stems. See Appendix A – Phragmites Best Management Practices document for a chart describing the differences.

There are currently about 30 known sites of invasive phragmites throughout King County and two locations are along the Sammamish River (Figure 12). One of these, in Bothell, has been controlled, with no plants seen in this location for at least four years (KCNWP 2012). The other, on the south bank in Kenmore across from the Swamp Creek Natural Area, is about 1,500 square feet in area. It has been treated yearly for several years and is in decline, but requires ongoing monitoring and treatment to move toward eradication. This site is on private land and is being managed by the property owner with the assistance of the KCNWCP.

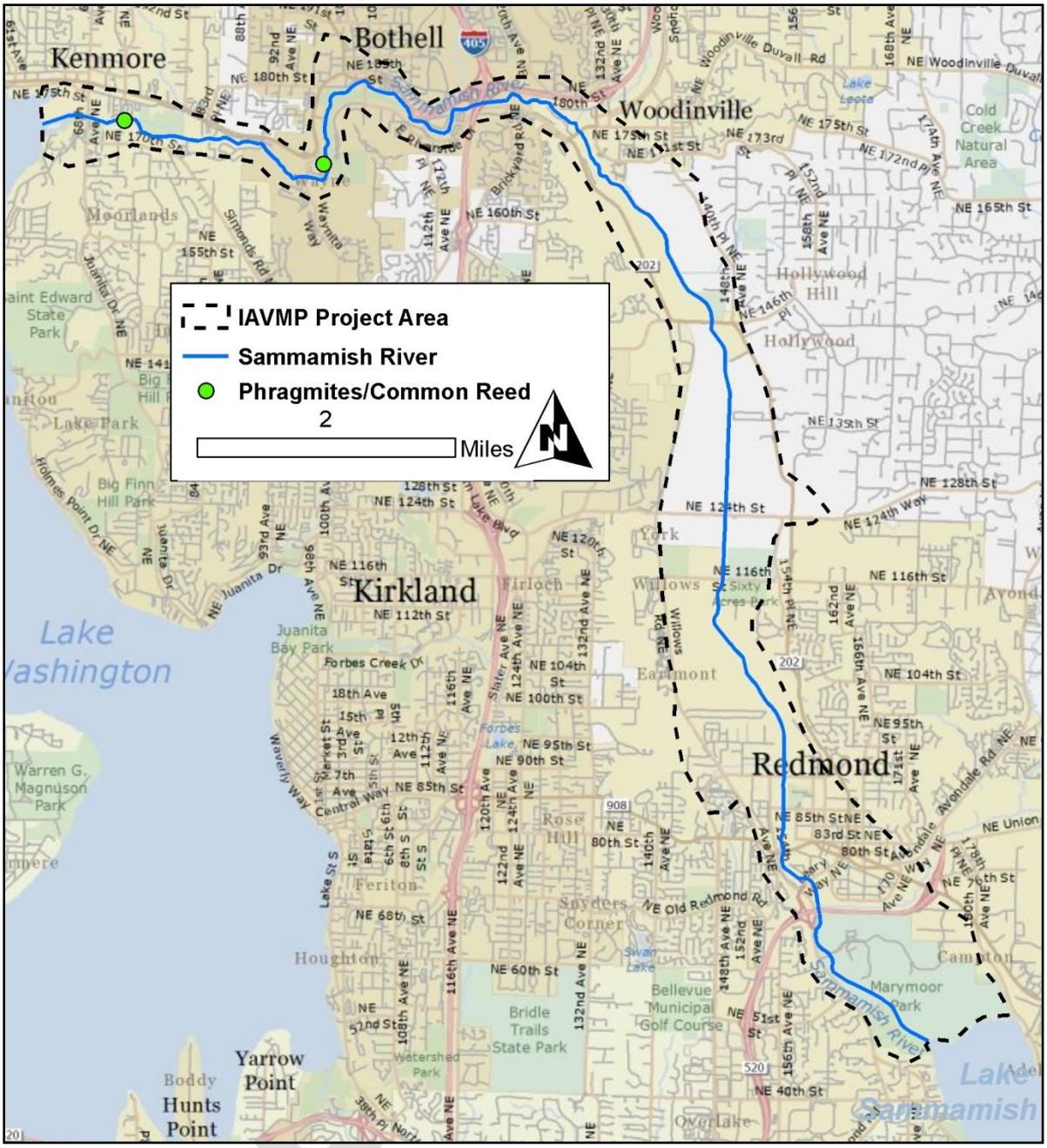

Figure 12. Phragmites/common reed locations in the IAVMP Project Area.

Since seeds of phragmites are wind-borne, new populations could become established elsewhere along the river from the existing Kenmore site as well as from other small sites in the region. The greatest immediate threat phragmites poses is to Squire's Landing Park Natural Area in Kenmore (just upstream of the Kenmore phragmites site river bank right), but other wetlands and river bank could become infested as well. While these plants may occur in other yet-to-be-found locations on the river, phragmites species has not become wide spread. The relative small area infested by this species presents a good opportunity to achieve eradication along the river if control efforts continue and any new infections are promptly reported and dealt with.

SUBMERSED AND FLOATING AQUATIC VEGETATION AND WEEDS

While the waterbody is technically a river, because of its depth and slow current, the submersed plants that inhabit it are generally more commonly found in lakes. The most common submersed plant in the river is aquatic noxious weed Brazilian elodea. Except for the very center of the channel, this plant occupies most of the river channel from the weir at Marymoor Park downstream for about seven miles (Figure 14). From about river mile 5.5 downstream to Lake Washington, there have been only scattered and small patches of Brazilian elodea found. The plant has been surveyed for many years by the King County Noxious Weed Control Program. Brazilian elodea is not designated for control in Lake Sammamish, Lake Washington, or the Sammamish River because it is already widespread in these waterbodies.

The other submersed aquatic noxious weeds are Eurasian watermilfoil and curly-leaf pondweed. While not mapped, the plant is known to grow in small patches throughout the length of the river. Eurasian watermilfoil is a common problem in the littoral zone of small and large lakes (including Lake Sammamish and Lake Washington) (KCNWCP, 2012). Both submerged weeds are not regulated in King County because they are already wide spread.

There are also a few patches of floating aquatic noxious weeds, primarily at the origin and terminus of the river. This floating plant is the Class C noxious weed fragrant water lily and is non-regulated in King County.

The Sammamish River does contain some native submersed vegetation, including coontail, narrow leaf bur-reed, common waterweed, and pondweed species. These plants are relatively uncommon, especially in the first five miles or so of the river because of crowding by Brazilian elodea.

Egeria densa (Brazilian elodea)

This noxious weed is a submersed, freshwater perennial plant found in both still and flowing waters including lakes, ponds and quiet streams (KCNWCP, 2010a). Brazilian elodea tends to form dense monospecific stands that can cover hundreds of acres.

Native to Brazil and Argentina, Brazilian elodea is a popular aquarium plant often sold in pet stores and available in school science kits under the name *Anacharis*. When it is introduced into freshwater, it forms dense beds that reduce water quality and impede recreational activities. It is illegal to buy or sell this plant in Washington State. It was first reported in the United States in Millneck, Long Island where it was collected in 1893. It has long been sold as an aquarium plant in the United States and thought to have infested many lakes through aquarium "dumps."

Brazilian elodea is a very aggressive submerged aquatic plant that can out compete native aquatic plants, forming dense monotypic stands (KCNWCP, 2010a). It can reduce biodiversity, change the predator/prey relationship in the waterbody, and adversely impact the food web. Dense stands, where the plant "tops out", can prevent wind mixing and lead to extensive areas of low water oxygen level. Stagnant mats create mosquito breeding habitat and increase the water temperature underneath by absorbing sunlight. When stands of Brazilian elodea die back in the fall the resulting decay uses up dissolved oxygen and adds nutrients to the water, conditions that can increase algae growth.

Additionally, dense stands of the plant impact recreation by eliminating swimming opportunities, fouling boat motors, and snagging fishing lines.

Identifying Brazilian elodea can be difficult it is important to get an expert to confirm the species before planning any control measures. The plant grows mostly underwater but can form dense mats along the surface. A perennial that grows in up to 20 feet of water, Brazilian elodea spreads by fragmentation, but is not known to seed in North America (Figure 13). The plant is generally submersed (rooted) but sometimes forms floating mats. Three-petalled white flowers with a yellow center appear floating on the surface of the water from late spring to early fall. Leaves of Brazilian elodea are bright to dark green, 2-4 cm wide by 3-5 cm long, and grow in whorls of 4-8 and the stems are very leafy compared to the native elodea, common waterweed (*Elodea canadensis*). The leaf edges appear smooth to the naked eye (native elodea has 3 leaves in a whorl) (KCNWCP, 2010a).

Figure 13. Brazilian elodea.

In the King County area, *Egeria densa* has been observed to overwinter in a dormant-like, evergreen condition. Seeds and/or female flowers have never been reported from Brazilian elodea populations established in the United States. The absence of sexual reproduction in introduced populations of Brazilian elodea emphasizes the importance of the vegetative growth phase of the plant.

This weed is so proficient that it can outcompete the common aquatic noxious weed, Eurasian watermilfoil. The Brazilian elodea infestation in the Sammamish River likely originated from the upstream population that exists in Lake Sammamish. That infestation, which occurs in the relatively shallow north end of the lake, provides a source of viable plant fragments that can re-infest the River.

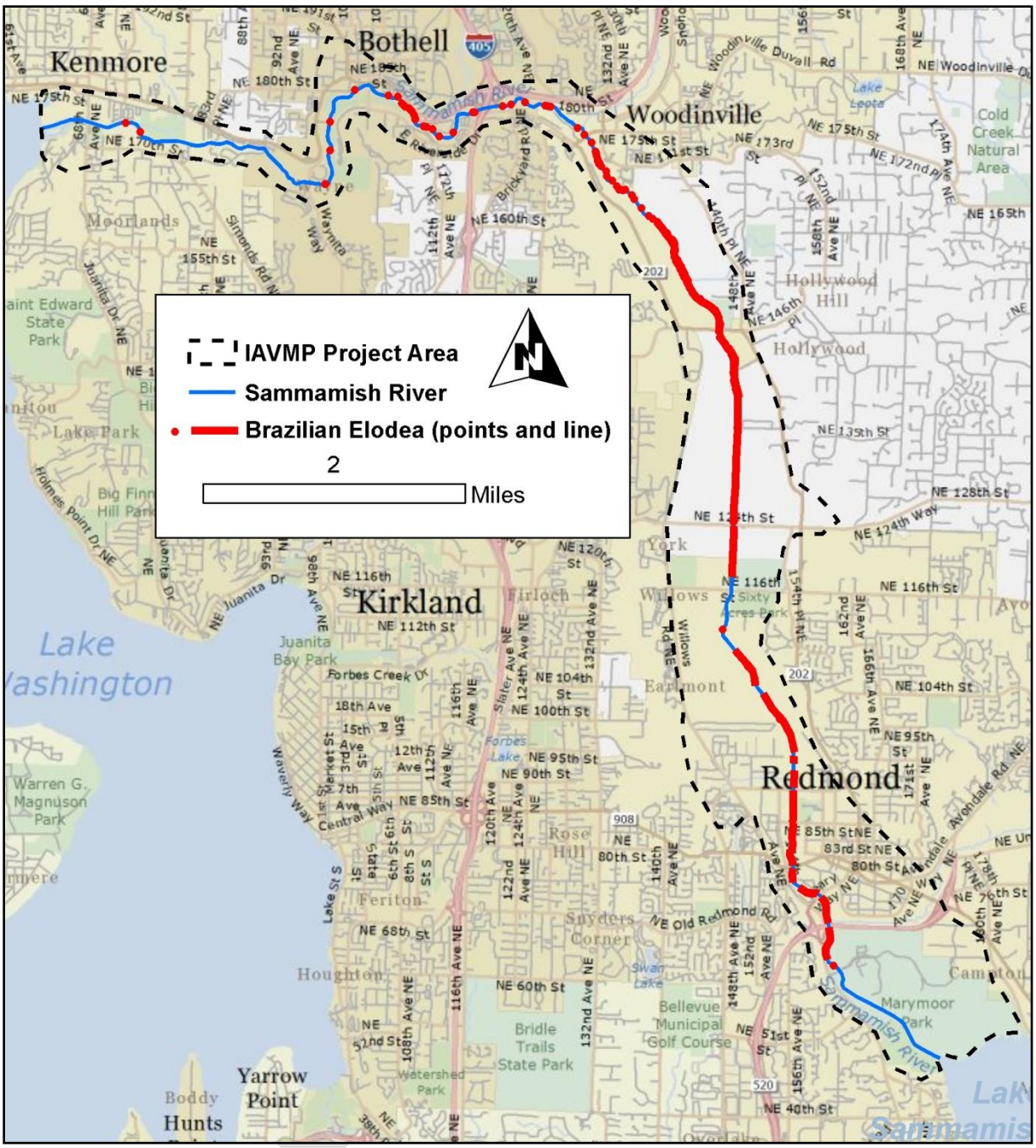

Figure 14. Map of Brazilian Elodea in the Sammamish River, 2009 – 2012 survey data

While still available for sale elsewhere in the U.S., the plant is illegal to sell in Washington and is a non-regulated Class B Noxious Weed on the Sammamish River. In King County, it is established in Lakes Washington, Sammamish, Union, Fenwick, and Dolloff as well as the Sammamish River. The plant has recently been discovered at Fisherman's Terminal on the Lake Washington Ship Canal. Except for the very center of the channel, this plant occupies most of the river channel from the weir at Marymoor Park downstream for about seven miles (Figure 14). From about river mile 5.5 downstream to Lake Washington, there have been only scattered and small infestation of Brazilian elodea found.

SECTION 6 - MANAGEMENT ALTERNATIVES

A wide variety of control methods have been developed to address the general problem of aquatic noxious weeds. The suitability of control methods for specific plants such as purple loosestrife or Brazilian elodea varies widely. All known control options (aquatic herbicide, manual control methods, mechanical control methods, environmental manipulation, biological control) have been considered and evaluated for each noxious weed species as it relates to the conditions on the Sammamish River (Table 8). This matrix separates potential control methods into those that warrant further investigation (either for whole waterbody treatment or for small-scale temporary control) and those methods that are not applicable on the Sammamish River.

Table 8. Control Option Matrix for Regulated Noxious Weeds on the Sammamish River.

broad control method category	Specific method	compatible with Sammamish River water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for garden loosestrife	further consideration?	effectiveness for phragmites/ common reed	further consideration?	effectiveness for Brazilian elodea	further consideration?
Manual Control Methods	Hand pulling	yes, small areas, follow-up work	effective in some situations (where soil it very wet and not rocky), can be part of an IPM solution	yes[1]	not possible, breaks off from long rhizomes leaving root fragments behind	no	not possible, breaks off from rhizomes leaving root fragments behind	no	A useful method in shallow water, must remove leafy part of plant along with root crown to prevent re-growth. Labor intensive.	YES
Manual Control Methods	Digging	yes, small areas, follow-up work	Suitable for small plants or pioneering stands. Carefully dig out as much root and rhizome as possible.	yes[1]	Suitable for small plants or pioneering stands. Carefully dig out as much root and rhizome as possible.	yes[1]	Suitable for small plants or pioneering stands. Carefully dig out as much root and rhizome as possible.	yes[1]	only successful for very small areas, all fragments must be removed, increases turbidity.	no[1]
Manual Control Methods	diver hand pulling	yes	not relevant	no	not relevant	no	not relevant	no	A useful method in deeper water, must remove leafy part of plant along with root crown to prevent re-growth. Labor intensive. Snorkel divers in shallower water, SCUBA divers in deeper water. Stringent safety protocols should be employed[2].	YES

*Table 8 (*continued*). Control Option Matrix for Regulated Noxious Weeds on the Sammamish River.*

broad control method category	Specific method	compatible with Sammamish River water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for garden loosestrife	further consideration?	effectiveness for phragmites/ common reed	further consideration?	effectiveness for Brazilian elodea	further consideration?
Manual Control Methods	raking	no	not relevant	no	not relevant	no	not relevant	no	not practical, causes fragmentation	no
Environmental Manipulation Control Methods	bottom barriers/ tarp staking	area of infestation too large	tarping can suppress growth in some situations, but will not eradicate.	no[1]	tarping can suppress growth in some situations/small areas but will not eradicate; covering must extend several feet beyond the edges of the infestation; follow-up work required	no[1]	tarping can suppress growth in some situations, but will not eradicate.	no[1]	Need to be very securely anchored in moving water impractical for large infestations	no[1]
Environmental Manipulation Control Methods	Shading	yes, shading of noxious weeds, via growth of taller vegetation, to reduce or control infestations may be an option along the Sammamish River	While purple loosestrife plants grow well in conditions raging from full sun to %50 shade, plants do exist, but not thrive in shady areas. Deep shade may reduce the density and vigor of plants.	yes[3]	garden loosestrife is know to thrive in full sun but also be shade tolerant.	no	Seedlings are susceptible to shading and shading by trees & shrubs can decrease plant vigor.	yes[3]	May not be able to tolerate shaded water. Very little information about effect of shading on Brazilian elodea control.	yes[3]
broad control method category	Specific method	compatible with Sammamish River water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for garden loosestrife	further consideration?	effectiveness for phragmites/ common reed	further consideration?	effectiveness for Brazilian elodea	further consideration?
Environmental Manipulation Control Methods	burning	not practice because not usually effective and danger of burning near urban areas; air quality concerns.	not relevant	no	not relevant	no	Generally, prescribed burning does not reduce the growing ability of phragmites unless root burn occurs which seldom happens because the rhizomes are usually covered by a layer of soil, mud and/or water.	no	not relevant	no

*Table 8 (*continued*). Control Option Matrix for Regulated Noxious Weeds on the Sammamish River.*

broad control method category	Specific method	compatible with Sammamish River water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for garden loosestrife	further consideration?	effectiveness for phragmites/ common reed	further consideration?	effectiveness for Brazilian elodea	further consideration?
Environmental Manipulation Control Methods	water level drawdown	not possible on the Sammamish River, no water control structures.	not relevant	no	not relevant	no	not relevant	no	not relevant	no
Mechanical Control Methods	Cutting	yes	when cut at the base at flower-drop, will control the plant for the year. Remove and bag all plant parts. Will not eradicate. Can be part of an IPM solution	yes[1]	Cutting alone is not a control option for garden loosestrife, new plants will grow from rhizomes.	no	Cutting/mowing without use of herbicide should be done in late July (before tassel set) when most of the energy is in the stalk and not the roots. Cutting during other times may stimulate growth.	yes[1]	Will not control and has actually resulted in increased vigor of cut plants. Cut fragments may spread infestation.	no
Mechanical Control Methods	Harvesting machine	can't be done around docks, logs and other in-water obstructions, may be impossible in the moving water	not relevant	no	not relevant	no	not relevant	no	will cause extensive fragmentation and spread infestation, impractical in the river	no
Mechanical Control Methods	Rotovation machine	can't be done around docks, logs and other in-water obstructions, may be impossible in the moving water	not relevant	no	not relevant	no	not relevant	no	will cause extensive fragmentation and spread infestation, turbidity, impractical in the river	no
Mechanical Control Methods	Diver dredging	yes	not relevant	no	not relevant	no	not relevant	no	uses a suction dredge to remove plants from soil. Expensive. Has proved effective in flowing water.	yes

*Table 8 (*continued*). Control Option Matrix for Regulated Noxious Weeds on the Sammamish River.*

broad control method category	Specific method	compatible with Sammamish River water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for garden loosestrife	further consideration?	effectiveness for phragmites/ common reed	further consideration?	effectiveness for Brazilian elodea	further consideration?
Mechanical Control Methods	Sediment agitation (weed rollers)	yes	not relevant	no	not relevant	no	not relevant	no	not practical in moving water or large infestations	no
Biological Control Methods	grass carp	Grass carp are not allowed in flowing water	not relevant	no	not relevant	no	not relevant	no	Grass carp are not allowed in flowing water	no
Biological Control Methods	*Galerucella* beetles for purple loosestrife	yes	already on site, scattered. Not effectively reducing population. Must be combined with manual control of seeds.	yes					not relevant	no
Biological Control Methods	other biocontrol agents for specific plants	possibly, difficult to acquire if agents are known	<u>seed and root feeding weevils</u>: Not currently on site, difficult to obtain. Would take several years for populations to build to controlling levels & require with manual control of seeds.	yes	No biological control agents are presently known. No research is currently being	no	There are no effective biocontrol agents for phragmites at this time.	no	research is being done but there are currently no accepted biocontrol agents for Brazilian elodea in moving water	no
Chemical Control Methods	Diaquat	legal formulation not effective, also chemical control in flowing water is very difficult and risky to non-target plants and animals.	not relevant	no	conducted.	no	not relevant	no	Effective formulations are illegal in WA state waters[4]. Chemical control in flowing water is very difficult and risky to non-target plants and animals.	no

*Table 8 (*continued*). Control Option Matrix for Regulated Noxious Weeds on the Sammamish River.*

broad control method category	Specific method	compatible with Sammamish River water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for garden loosestrife	further consideration?	effectiveness for phragmites/ common reed	further consideration?	effectiveness for Brazilian elodea	further consideration?
Chemical Control Methods	Endothall	not effective, also chemical control in flowing water is very difficult and risky to non-target plants and animals.	not relevant	no	not relevant	no	not relevant	no	Not effective for Brazilian elodea control[4,5]. Chemical control in flowing water is very difficult and risky to non-target plants and animals.	no
Chemical Control Methods	Fluridone	requires whole-waterbody treatment, also chemical control in flowing water is very difficult and risky to non-target plants and animals.	not relevant	no	not relevant	no	not relevant	no	only WA state permitted herbicide shown to be effective on Brazilian elodea. Chemical control in flowing water is very difficult and risky to non-target plants and animals.	yes
Chemical Control Methods	Glyphosate	may be effective tool for phragmites control	not desirable for purple loosestrife control; it is non-selective and monocots (cattails, grasses, and sedges) may be unintentionally damaged in during spraying	no	not desirable for garden loosestrife control; it is non-selective and monocots (cattails, grasses, and sedges) may be un-intentionally damaged in during spraying	no	Effective, if properly applied. Non-selective, will control both grasses and broadleaf plants, apply carefully	yes	not relevant	no
Chemical Control Methods	Imasapyr	may be most effective tool for phragmites and garden loosestrife control	effective for purple loosestrife control, slow acting chemistry; it is non-selective and monocots (cattails, grasses, and sedges) may be unintentionally damaged in	yes	tests suggest a low concentration of imazapyr (0.75%) applied in early summer (June) can be very effective; Non-selective, will control both grasses and broadleaf plants, apply carefully	YES	Very effective, if properly applied. Non-selective, will control both grasses and broadleaf plants, apply carefully	YES	not relevant	no

			during spraying							

*Table 8 (*continued*). Control Option Matrix for Regulated Noxious Weeds on the Sammamish River.*

broad control method category	Specific method	compatible with Sammamish River water body characteristics	effectiveness for purple loosestrife	further consideration?	effectiveness for garden loosestrife	further consideration?	effectiveness for phragmites/ common reed	further consideration?	effectiveness for Brazilian elodea	further consideration?
Chemical Control Methods	Triclopyr TEA	aquatic formulations are compatible for use	effective, if properly applied. Selective: won't harm monocots (cattails, grasses, and sedges)	yes	moderately effective, re-growth often occurs with treated plants. Selective: won't harm monocots (cattails, grasses, and sedges)	yes	not effective on monocots (grasses)	no	not relevant	no
Chemical Control Methods	2,4-D Amine	Some formulations are compatible	Potentially effective but not recommended for control. Toxic to fish and aquatic invertebrates.	no	Potentially effective but not recommended for control. Toxic to fish and aquatic invertebrates.	no	not effective on monocots (grasses)	no	not relevant	no
No Action	No Action	With many existing and planned shoreline habitat restoration projects along the River, some weed control is already happening.	no action towards control would result in continued seed and propogue spread down stream into un-infested habitat areas of the Sammamish River and Lake Washington	no	no action towards control would result in continued seed and propogue spread down stream into un-infested habitat areas of the Sammamish River and Lake Washington	no	no action towards control would result in continued seed and propogue spread down stream into un-infested habitat areas of the Sammamish River and Lake Washington	no	no action towards control would result in continued seed and propogue spread down stream into un-infested habitat areas of the Sammamish River and Lake Washington	no

[1]method can be employed by individual property owners for small-scale temporary control or potentially for follow-up control after good initial control has been achieved.

[2]Safety protocols, such as those developed by the Thurston County Noxious Weed Board specifically address the unique job hazard concerns that come with SCUBA diving work. http://www.co.thurston.wa.us/tcweeds/special-projects.htm

[3]shading, while not effective as a method for initial control of the plants, may be part of a long-term IPM strategy for control, particularly when combined with restoration plantings.

[4]Diquat and endothall have only suggested successful results in combination with copper compounds, but the use of copper is illegal in most Washington State waters (including the Sammamish River) due to its demonstrated toxicity to juvenile Salmonids.

[5]WA Department of Ecology states that Endothall is "not effective in controlling ... Brazilian elodea." : http://www.ecy.wa.gov/programs/wq/plants/management/aqua028.html

A Word about Integrated Pest Management

The preferred approach for weed control is Integrated Pest Management (IPM). IPM involves selecting from a range of possible control methods to match the management requirements of each specific site. The goal is to maximize effective control and to minimize negative environmental, economic and social impacts. IPM uses a multifaceted and adaptive approach. Control methods are selected that reflect the available time, funding, and labor of the participants, the land use goals, and the values of the community and landowners. Management of noxious weeds will require dedication over a number of years, and should allow for flexibility in method as appropriate.

THE "NO ACTION" ALTERNATIVE

Among all the considered control options, one management alternative that should be considered is the option of "no action." In this situation the "no action" option would not necessarily mean that no work gets done on the aquatic invasive plants, however it means there is no unified effort to address all the invasive weeds together. Work may be done in pockets up and down the river but there is no guarantee for success of management of all regulated noxious weeds. The effects of "no action" on each of the species varies; generally, the plants would be able to continue sending propogules downstream into further reaches of the Sammamish River corridor, Lake Washington, and beyond. Other effects of the "no action" alternative are that the weeds continue to spread along the shoreline and within the river, creating monocultures and altering habitat for the wildlife that uses the river.

The potentially negative side effects of all the considered control options are considered against the "no action" alternative. For example the option of controlling purple loosestrife with herbicide considers the negative effect of herbicide spray on non-target plants compared to not controlling purple loosestrife in the first place.

Purple loosestrife (*Lythrum salicaria*)

For more information on the following purple loosestrife control methods reference Appendix A – Purple Loosestrife Best Management Practices document. A large, scattered infestation of purple loosestrife exists upstream on the shores of Lake Sammamish, making eradication of the plant on the shore of the river impossible until the Lake Sammamish infestation is addressed. Still, focusing control of the plant in targeted areas or targeted reaches of the river can facilitate habitat restoration, and encourage plant diversity.

Hand Pulling and digging (only suitable for small areas or used in combination with other methods)

Hand pulling or digging of purple loosestrife plants is possible in areas where plants are growing out of soft substrate and the root mass of the plants are reachable. The entire root mass must be removed, bagged, and disposed of. Plants that are growing in rock or riprap, in amongst large downed wood, or amongst woody vegetation may not be able to be completely removed using this method. Additionally, while hand pulling may be feasible on a small scale, using hand pulling and digging for the entirety of the river shoreline would be prohibitively expensive. Using hand pulling and digging methods to control purple loosestrife may work on the Sammamish River only if it is part of an IPM solution that incorporates several control tactics such as biological control, long-term persistent cutting, weed fabric and selective herbicide use.

Weed Fabric/Tarps (only suitable for small areas)

The use of thick cardboard or plastic, staked down, and covered by six inches of mulch to cover closely cut purple loosestrife plants can prevent seed spread but will not eradicate the plant. Weed fabric is only an option where the terrain is flat soil and not interrupted by logs, other vegetation, or rock. Weed fabric also needs to be checked often because it can become damaged and will need to be repaired or re-installed. Using weed fabric to control purple loosestrife may work on the Sammamish River only if it is part of an IPM solution that incorporates several control tactics such as hand pulling, biological control, long-term persistent cutting, and selective herbicide use.

Cutting (used in combination with other methods)

Cutting plants at the base when in flower may prevent seeding, but cut plants may continue to produce flowers. Sites should be consistently and regularly monitored from the beginning of flowering (early July) until first frost to cut and remove any subsequent flowers. Cutting will not kill the plants, and they will need to be controlled every year. Care must also be taken to properly dispose of root and stem fragments to prevent the growing of new plants. Cut plant parts must not be left on site, because root and stem fragments can form new plants. Using cutting to control purple loosestrife may work on the Sammamish River only if it is part of an IPM solution that incorporates several control tactics such as hand pulling, biological control, weed fabric, and selective herbicide use.

Biological Control (used in combination with other methods)

Purple loosestrife population density and the number of flowering plants can be reduced using this method, but there will always be some plants remaining. Releases of the biological agents should be made only at sites where loosestrife infestations are large and immediate eradication of the weed is not the primary objective. Biological control can take up to six years to have a significant impact on the infestation.

Galerucella beetles have been released in the southeast part of Marymoor Park by (or for) the King County Noxious Weed Control Program (KCNWP) in 1997, 1998, 1999, 2000, 2001, 2002, 2004, 2005, 2006, and 2007. They were also released along the Sammamish River in Marymoor Park in 2003 and 2007. *Galerucella* beetles are already on site but have not been able to effectively reduce the purple loosestrife infestation. The use of *Galerucella* beetles needs to be combined with the removal and bagging of plant flowers.

Other biocontrol methods that target purple loosestrife, such as use of seed feeding weevils and root feeding weevils, are more difficult to obtain than *Galerucella* beetles. They have not yet been tried on the Sammamish River. If released they would take several years to build up populations to levels that would result in a significant impact on the population. The use of seed feeding weevils and root feeding weevils for purple loosestrife control needs to be combined with the removal and bagging of plant flowers. By its nature, biocontrol methods will, at best, result in reduced infestation of the target plant but not result in eradication.

Chemical Control – most effective initial control method

For large and widespread infestations of purple loosestrife, herbicide use may be necessary for effective control. The application of herbicide to the emergent purple loosestrife is best conducted by manual spot applications. Control of purple loosestrife is most effectively achieved using a selective herbicide such as an aquatic approved version of triclopyr (TEA) or 2,4-D (Amine)(see Appendix B for herbicide

label). Triclopyr-TEA in particular has been very effective in killing purple loosestrife plants and has the lowest human and ecological side effects. Selective herbicides also have the advantage of not harming monocot plants (native cattails, grasses, sedges, etc.).

While non-selective, an aquatic approved version of imazapyr is also effective at controlling purple loosestrife plants. Experienced herbicide applicators can spot spray target only purple loosestrife plants and avoid damage to adjacent monocot plants. Imazapyr is relatively slow acting so application should occur early – mid way through the summer (before late August/September) – to ensure that the chemical will have time to affect plant growth before seed production.

These aquatic herbicides must be used with a Washington State Department of Ecology approved aquatic surfactant. An experienced and licensed aquatic herbicide applicator can selectively target individual emergent weed species and limit collateral damage to other species to a minimum. This is especially true when infestations are small so that large areas with a diverse plant distribution don't have to be treated. Since the emergent noxious weed infestations at the Sammamish River are still confined largely to the shoreline, it should be relatively simple for the applicator to avoid significant collateral damage and preserve the native plant community.

Treatment of purple loosestrife will likely occur twice during the growing season in order to ensure that no plants were missed as the vegetative part of the plants can be hard to spot among other vegetation. In sensitive areas or areas prone to erosion, careful spot-spraying will create fewer disturbances than manual or mechanical control. Areas should be monitored for new plants germinating from the seed bank for several years following treatment. In some cases several years of treatment may be necessary.

Garden loosestrife (*Lysimachia vulgaris*)

For more information on the following garden loosestrife control methods reference Appendix A – Garden Loosestrife Best Management Practices (BMP) document. . A large, scattered infestation of garden loosestrife exists upstream on the shores of Lake Sammamish, making eradication of the plant on the shore of the river impossible until the Lake Sammamish infestation is addressed. Additionally, actual eradication of garden loosestrife is very difficult. Still, focusing control of the plant in targeted areas or targeted reaches of the river can facilitate habitat restoration, and encourage plant diversity.

Hand Pulling and Digging (only suitable for small areas or used in combination with other methods)

Hand pulling of garden loosestrife is not possible; the plant breaks off from long rhizomes leaving root fragments behind. Digging of garden loosestrife plants is possible in areas where plants are growing out of soft substrate and the root mass of the plants are reachable. The entire root mass must be removed, bagged and disposed of. Plants that are growing in rock or riprap, in amongst large downed wood, or amongst woody vegetation may not be able to be completely removed using this method. Additionally, while digging may be feasible in the small scale, using this technique on the whole river scale would be prohibitively expensive and potentially cause erosion problems. Using digging methods to control garden loosestrife may work on the Sammamish River only if it is part of an IPM solution that incorporates several control tactics such as biological control, long-term persistent cutting, weed fabric, and selective herbicide use.

Weed Fabric/Tarps (only suitable for small areas)

The use staked down tarps to cover closely cut garden loosestrife plants can slow down growth and prevent seed spread, but will not eradicate the plant. Tarps are only an option where the terrain is flat and not interrupted by logs, other vegetation, or rock. The covering must extend several feet beyond the edge of the infestation and be weighted so the plants cannot push it up. The edges of the covered area must be monitored for plants coming up from rhizomes extending beyond the sheet. Weed fabric will need to be checked often for damage or gaps and repaired or re-installed as needed, especially in areas that are prone to seasonal flooding.

Using weed fabric to control garden loosestrife may work on the Sammamish River only if it is part of an IPM solution that incorporates several control tactics such as digging, long-term persistent cutting, and selective herbicide use.

Cutting (used in combination with other methods)

Cutting alone is not a control option for garden loosestrife; new plants will grow from rhizomes. Cutting plants at the base when in flower may prevent seeding, but cut plants may continue to produce flowers and root mass. Cutting will not kill the plants, and they may continue to expand despite of it. Cut plant parts must not be left on site, because root and stem fragments can take root and form new plants. Using cutting to control garden loosestrife may work on the Sammamish River only if it is the first step of an IPM solution that incorporates several control tactics such as digging, tarping, and selective herbicide use.

Chemical Control --- most effective initial control method

For large and widespread infestations of garden loosestrife, herbicide use may be necessary for effective control. The application of herbicide to the emergent and upland garden loosestrife is best conducted by manual spot applications. Informal trials done by the KCNWP in 2011 suggest a low concentration of imazapyr (0.75%) applied in early summer (June) can be very effective in controlling garden loosestrife. Less complete control has been achieved by using higher concentrations of imazapyr later in the summer (August). While producing the most effective control results to date, imazapyr has the drawback of being non-selective, meaning it will control both grasses and broadleaf plants. When applying non-selective herbicides amongst native plants, great care must be taken to prevent unintended control.

The selective herbicide triclopyr is also commonly used to treat garden loosestrife, although has been found to be less effective than imazapyr. Apply triclopyr when plants are in the mid- to full-bloom stage. Application to preflowering plants or seedlings may also be effective, but unless the extent of the infestation is well known, plants can be difficult to locate when not in flower. Triclopyr is a selective herbicide and will kill only dicots. It will not harm monocots such as grasses, sedges, cattails and many native aquatic plants.

Glyphosate herbicide is occasionally used to treat garden loosestrife, although it has been found to be less effective than imazapyr. Additionally, like imazapyr, glyphosate is nonselective and it will injure or kill other vegetation contacted by the spray including grasses, cattails and other monocots.

These aquatic herbicides must be used with a Washington State Department of Ecology approved aquatic surfactant.

An experienced and licensed aquatic herbicide applicator can selectively target individual emergent weed species and limit collateral damage to other species to a minimum. Since the emergent noxious weed infestations at the Sammamish River are still confined largely to the shoreline, it should be relatively simple for the applicator to avoid significant collateral damage and preserve the native plant community.

Treatment of garden loosestrife will likely occur twice during the growing season in order to ensure that no plants were missed as the vegetative part of the plants can be hard to spot among other vegetation. In sensitive areas or areas prone to erosion, careful spot-spraying will create fewer disturbances than manual or mechanical control. For several years following treatment, areas should be monitored for new plants germinating from the seed bank. It is common that several years of treatment are necessary.

Phragmites/Common Reed (*Phragmites australis*)

For more information on the following phragmites/common reed control methods reference Appendix A – Common Reed-Phragmites Best Management Practices document. Since there are only a few patches of phragmites along the River (figure 14) eradication may be the goal for these invasive plants.

Hand Pulling and Digging (only suitable for small areas or used in combination with other methods)

Hand pulling of phragmites is not possible; the plant breaks off from rhizomes leaving root fragments behind. Digging of phragmites plants is possible in areas where plants are growing out of soft substrate and the root mass of the plants are reachable. Young infestations may have shallow roots, however mature infestations may have rhizomes up to six feet deep and the entire root mass must be removed, bagged, and disposed of. Plants that are growing in rock or riprap, in amongst large downed wood, or amongst woody vegetation may not be able to be completely removed using this method. Additionally, while digging may be feasible on a small scale, using this technique for the whole river would be prohibitively expensive and potentially cause erosion problems. Using digging methods to control phragmites may work on the Sammamish River only if it is part of an IPM solution that incorporates several control tactics such as biological control, long-term persistent cutting, weed fabric, and selective herbicide use.

Weed Fabric/Tarps (only suitable for small areas)

The use of thick cardboard or plastic, staked down, and covered by six inches of mulch to cover closely cut phragmites plants can prevent seed spread but will not eradicate the plant. Weed fabric is only an option where the terrain is flat and not interrupted by logs, other vegetation, or rock. Weed fabric also need to be checked often because it can become damaged and will need to be repaired or re-installed. Using weed fabric to control phragmites may work on the Sammamish River only if it is part of an IPM solution that incorporates several control tactics such as hand digging, long-term persistent cutting, and selective herbicide use.

Cutting (used in combination with other methods)

Cutting or mowing phragmites is most effective after herbicide application (see Chemical Control section below), however, repeated annual cuttings without herbicide can reduce spread. Depending on site wetness, mowing or cutting treated plants once after an herbicide treatment is recommended during late summer to fall (August to first hard frost) or in winter when the ground is frozen. Cutting/mowing without use of herbicide should be done in late July (before tassel set) when most of the energy is in the stalk and not the roots. Cutting during other times may stimulate growth.

Cutting can be done using brush cutters (weed whackers), hedge trimmers, or loppers. Stems should be cut 4 inches above ground to minimize impact to wildlife and native plants. Cut stems should be collected immediately, bagged and removed from site to prevent possible seed spread and allow sunlight to reach the soil surface to promote germination of native plants. An annual regime of cutting and removing stems at the end of July for several years may result in successful control. Using cutting to control phragmites may work on the Sammamish River only if it is part of an IPM solution that incorporates several control tactics such as hand pulling, weed fabric, and selective herbicide use.

Chemical Control – most effective initial control method

For large and widespread infestations of phragmites, herbicide use may be necessary for effective control. The application of herbicide to phragmites is best conducted by manual spot applications. Control of phragmites is most effectively achieved using a broad spectrum (effective on both monocots and dicots) herbicide such as an aquatic approved version of imazapyr or glyphosate applied to actively growing plants (full flower) (*see Appendix B for herbicide label*). Imazapyr in particular has been very effective in killing phragmites plants but does stay active in the soil longer than glyphosate. Triclopyr TEA or 2,4-D amine are not effective on grasses such as phragmites because they are intentionally formulated to avoid damage to monocots such as grass.

Herbicide application in mid-summer (full flower stage) followed by cutting (several weeks later once the stems and leaves have died) will encourage native plant growth and allows for identification of phragmites re-growth for herbicide spot treatment in the future. These aquatic herbicides must be used with a Washington State Department of Ecology approved aquatic surfactant.

An experienced and licensed aquatic herbicide applicator can selectively target individual emergent weed species and limit collateral damage to other species to a minimum. This is especially true when infestations are small so that large areas with a diverse plant distribution don't have to be treated. Since the emergent noxious weed infestations at the Sammamish River are still confined largely to the shoreline, it should be relatively simple for the applicator to avoid significant collateral damage and preserve the native plant community.

In sensitive areas or areas prone to erosion, careful spot-spraying will create fewer disturbances than manual or mechanical control. For several years following treatment, areas should be monitored for new plants germinating from the seed bank. In some cases several years of treatment may be necessary.

Brazilian elodea (*Egeria densa*)

For more information on the following Brazilian elodea control methods reference Appendix A – Brazilian Elodea Best Management Practices document. An infestation of Brazilian elodea exists upstream in the north end of Lake Sammamish, making eradication of the elodea in the river impossible until the Sammamish Lake infestation is addressed. Still, small areas or targeted reaches of the river can be cleared of the plant to facilitate water flow, habitat restoration, and encourage plant diversity.

Hand Pulling and Cutting (only suitable for small areas)

Hand pulling can be used to temporarily control Brazilian elodea in a small area if repeated on a regular basis. Hand pulling from the shoreline or a boat will not eradicate the plant from a water body and *is impractical for large infestations*. All pulled plant parts must be removed from the water, and an HPA pamphlet permit required. Several years of monitoring are needed for signs of plants growing from root

fragments and from the seed bank. Brazilian elodea can be composted on dry land or placed in yard waste bins. Cutting of Brazilian elodea is not recommended as it will likely increase the infestation through fragmentation.

Snorkel Hand Pulling (suitable for small areas or follow-up control)

Snorkel hand pulling involves the use of snorkelers to carefully pull and bag entire Brazilian elodea plants. Snorkelers are used instead of divers because the river water levels are low enough that it makes diver hand pulling impractical and snorkelers would be able to navigate the 5 feet or so water depth much easier. Snorkelers are able to target just Brazilian elodea plants and carefully search the area for missed plants. This method can be used to target critical areas of habitat and water flow. Diver hand pulling is also an excellent way to continue control efforts after the infestation has reached a level where only maintenance is required.

Snorkel Dredging (most effective initial control method)

The use of a suction dredge to remove Brazilian elodea plants and roots from waterbody sediment has proved effective in flowing water. The technique involves one snorkeler dislodging the Brazilian elodea and another uses a vacuum hose to remove the plants (Simpson & Peoples, 2006). The dredge is mounted on a floating raft that is moved around the waterbody as work progresses. The plant and root material are collected in a basket for disposal off site. While whole river eradication of Brazilian elodea may be time and cost prohibitively expensive, the diver dredging technique, in combination with diver hand pulling may be appropriate for targeted reaches of the river.

Since 2004 Thurston County Noxious Weed Control Agency and other agencies have used SCUBA diver dredging and SCUBA diver pulling techniques to clear Brazilian elodea from 34 miles of-the Chehalis River. From 2005 to 2011 a 90% reduction in Brazilian elodea cover was achieved through the diver dredging technique, with diver hand pulling follow-up (TCNWCB, 2011). They were able to clear up to nearly 10 acres of Brazilian elodea from the river per year; a total of 300,000 pounds of plant material were removed over the eight years of the project (2011).

The Sammamish River is a much smaller and shallower river system than the Chehalis River and it is believe snorkelers would be appropriate to do the hand-pulling and snorkel dredging of Brazilian elodea within its channel. However, it could be possible that if deeper pools exist in the river a SCUBA diver team may need to be hired to clear those deeper areas out.

Any work done involving divers will need to carefully follow safety guidelines as outlined by Occupational Safety and Health Administration (OSHA), State, County, and local jurisdiction guidelines.

Bottom Barriers (only suitable for small areas)

An opaque bottom barrier can be used to suppress Brazilian elodea growth in small, discrete areas like at a boat launch or water intake. Barriers need to be very securely anchored and regularly cleaned because plants will root in the sediment that accumulates on top of them. Bottom barriers are not practical for large-scale infestations such as the entire infestation at the river and are not permanent.

Chemical Control

Chemical control of submersed plants, such as Brazilian elodea, in flowing water is difficult and requires careful consideration. While chemical control of the plant in small lakes has been successful in eradicating the plant, moving water and the presence of salmonid fish, makes the prospect very unlikely,

if not impossible in the Sammamish River. Also, as long as there is a source of plants (Lake Sammamish) using herbicides only as a control method, not an eradication method, does not make sense.

For large infestations of Brazilian elodea (in lakes) a round or two of herbicide treatment is often the most reasonable option for eradication. The only herbicide allowed in Washington waters that has been shown to be successful against Brazilian elodea is fluridone. Endothall and diquat have proven successful in combination with copper compounds, but the use of copper is illegal in most Washington State waters due to its demonstrated toxicity to juvenile salmonid (smolts). So, while the use of herbicide to treat Brazilian elodea in the Sammamish River may be theoretically possible, it is not practical.

SECTION 7 – INTEGRATED TREATMENT PLAN

The Sammamish River and its associated shoreline contain four listed noxious weed species whose presence has diminished the quality of the river as an ecological and human resource. The goal of the treatment plan is to halt and reverse the degradation caused by the targeted plants. The primary shoreline weeds include garden loosestrife (*Lysimachia vulgaris*), purple loosestrife (*Lythrum salicaria*) and phragmites/common reed (*Phragmites australis)*. All three of the shoreline plants are regulated through the King County Noxious Weed Council. The most wide spread aquatic invasive weed is Brazilian elodea (*Egeria densa*), and while Brazilian elodea is not a regulated weed in the Sammamish River, it does pose the greatest threat to the endangered species act listed salmon, Chinook.

All four species are highly aggressive and are difficult to control. The management goal for purple and garden loosestrife plant will be control rather than eradication as a large source of reinfestation seeds and propagules for these plants exist upstream on the shores of Lake Sammamish. Until the upstream purple and garden loosestrife plants are eradicated, control of the plants in targeted areas, such as restoration sites or adjacent to uninfested habitat, is the goal. The common reed/phragmites infestations along the river are relatively small and have been reducing in size over time as a result of herbicide treatments. A reasonable management goal for the phragmites population is eradication within a few years. Eradication of Brazilian elodea is not the goal because Lake Sammamish, which feeds the Sammamish River, has a heavy uncontrolled infestation of Brazilian elodea and as long as the infestation remains in the lake, it will be a source of infestation for the river.

It is recognized that there are other noxious weeds present within the Sammamish River system but these weeds are not regulated and therefore not the focus of this IAVMP. However, in the effort to create an integrated treatment plan, it is encouraged for any municipality, non-profit, local government or citizen group to approach every restoration project on the River with all the invasive weeds in mind. To help facilitate comprehensive restoration planning, BMPs for the non-regulated weeds are included in Appendix A.

All methods suggested for the regulated weeds combine to form an Integrated Pest Management (IPM) strategy that is a balance between target weed control and environmental protection.

Permits

Most aquatic weed control activities require permits. Many manual and mechanical control methods are covered under the “Aquatic Plants and Fish” pamphlet, a Hydraulic Project Approval (HPA) from the Washington Department of Fish and Wildlife that is free of charge and expedites the removal aquatic of noxious weeds. This HPA pamphlet permit is for individual land owners and cannot be applied to entire

waterbody. It is intended to allow shoreline property owners to control aquatic noxious weeds without having to go through expensive and complicated permitting. The HPA is not intended to be used to control "beneficial plants" or native plants that may be seen as weeds.

A National Pollutant Discharge Elimination System (NPDES) permit must be obtained before aquatic herbicides can be applied to natural water bodies in Washington State (including the Sammamish River). The Washington Department of Agriculture holds an NPDES permit for the management of noxious weeds growing in wet areas such as lake shores, freshwater wetlands, river banks, and estuaries. Licensed applicators can obtain coverage under this permit free of charge. For herbicide treatment of submerged plants (floating or submersed weeds) the project will need an Aquatic Plant and Algae Management NPDES permit from the Washington Department of Ecology. This permit must be held by the herbicide applicator or the legal entity hiring the applicator, it must be applied for at least sixty days before the herbicide application, and a permit fee applies. For the Sammamish River project, it is not recommended to do in river herbicide work so and NPDES permit from Washington State Department of Ecology will not be necessary.

General Control Strategy- Shoreline Plants

The primary problem the loosestrifes and phragmities pose to the river system is reducing the wildlife habitat quality and reducing plant diversity. Therefore, shoreline aquatic weed control work will initially focused in areas of existing good habitat such as restoration areas that are the most vulnerable to the continued presence of the plants. Other priority areas of shoreline weed removal work are areas that have restoration activities scheduled in the future and existing parklands. This targeted site management approach focus the first priority for control work on these three areas:

- existing restoration areas
- pending restoration areas
- managed parks

These key asset areas already (or soon will) have many resources (such as time, labor, and restoration plantings) invested in them and work done controlling regulated noxious shoreline weeds will continue those efforts. Furthermore, these sites are more likely to have follow-up work on the noxious weed control done by their owners and managers as compared to weed control done in unmanaged stretches of the river.

After these priority areas have been addressed, shoreline weed control should be targeted in areas adjacent to and particularly up stream of current control areas and uninvaded areas. This work will build a buffer around the initial target areas, resulting in less maintenance needed in the future to keep them from coming back because there will be less seed and plant propogules coming in from off site.

The final step in shoreline weed control strategy along the Sammamish River will focus on the unmanaged stretched of river bank. These are the lowest priority because long-term stewardship of weed removal is less likely to occur in these areas. In order for the removal process to be successful, long-term stewardship/maintenance is critical because a large seed and propogule source for both new purple and garden loosestrife plants exists upstream in Lake Sammamish.

1. Phase I – priority treatment areas
    a. existing restoration areas
    b. pending restoration areas

    c. managed parks
2. Phase II – secondary treatment areas
    a. Adjacent to primary treatment areas
    b. Upstream of primary treatment areas
3. Phase III – unmanaged river bank areas

Prioritizing treatment areas in this manner, rather than moving down stream along sequential river miles from Lake Sammamish to Lake Washington, will ensure that the most valuable shoreline habitat is addressed first. This strategy will also ensure that, if work on the project were to be halted before the five-year initial control time line is complete, an impact will have been made in the most important areas.

Identifying the best priority treatment area sites may take some time, but a place to start may be the November 2012 River Shoreline Vegetation survey conducted by the King County Noxious Weed Control program (Figure 6). This map, and the associated data table, can help the project managers find riverbank areas that currently have restoration plantings and an estimate of the existing noxious weed cover[1]. It is also important to seek out information from the agencies that installed and maintained these restoration areas. Direct communication with local cities (Kenmore, Bothell, Woodinville, and Redmond) and King County (Water and Land Resources Division) will be the most effective way to identify these "priority treatment areas." Some of the restoration planting areas may no longer be receiving any weed removal maintenance.

The schedule above is a proposed schedule and will need to be reassessed prior to the beginning of the project and each year during the project, depending on the density and distribution of plants found during surveys. Adaptive management is key when working on noxious weed control projects.

Since the management techniques and timing for Brazilian elodea control are quite different from the shoreline noxious weeds the submersed plant will be dealt with separately.

Surveys of Shoreline Plants

At the beginning of the project, a pretreatment survey of the Sammamish River shoreline will be conducted to map the regulated noxious weeds on GPS. A survey of purple loosestrife, garden loosestrife and common reed will occur in mid-summer prior to treatment. It is recommended that the survey be conducted from a small boat in the river, as this approach affords the best views of emergent aquatic vegetation such as purple loosestrife and garden loosestrife. All plants will be mapped using a GPS to create GIS files. King County staff and local municipalities will work together to gather survey information that may have been performed independently of this project.

Based on the initial surveys, the river shoreline will be broken into zones and prioritized by infestation density, area and, when appropriate, helping with restoration efforts along the shoreline. This method allows for thorough treatment on a prioritized schedule.

[1] The % noxious weed cover presented in the survey and associated data table represents an estimate of all listed noxious weeds, including the unregulated noxious weeds Hymalian blackberry and reed canarygrass. Often, the majority of the area of all the "listed noxious weeds" is occupied by the unregulated weeds. The % cover noxious weeds value may best serve as a general measure of the condition of the site and a tool to help prioritize control efforts of the regulated shoreline noxious weeds.

After each control event the zone will be resurveyed to assess the need for further follow-up using appropriate control methods. Each zone will be surveyed prior to initial control and after. As zones are treated they will be surveyed each subsequent year in order to help inform treatment decisions and allow for adaptive management. It is anticipated that every zone will receive one year of dedicated control work and then at least one year of follow-up survey and control work.

CONTROL OF SHORELINE PLANTS

Initial Control

Initial control of all three regulated noxious shoreline weeds be accomplished using a selective aquatic herbicide formulations of triclopyr (e.g.: Renovate3 ™) for purple loosestrife and imazapyr (e.g.: Habitat ™) for both garden loosestrife and common reed (*see **Appendix B** for herbicide label*).
The herbicides will be applied by a licensed aquatic herbicide contractor using boat mounted spot spraying equipment or a backpack sprayer. Treatment of these plants will occur in late summer, once most of the plants have flowered. It is also possible to access the plants from the Sammamish River trail with a backpack sprayer. A licensed herbicide applicator will be able to accurately spot spray plants on shore, avoiding non-target plants. Based off of post treatment surveys, a second spot treatment of plants using herbicide will be scheduled for mid-fall if deemed necessary.

Hand removal of any remaining loosestrife flowers or seed heads can be conducted in September. This flower and seed head removal will not prevent that specific plant from returning the flowing year, but will prevent further spread of the overall infestation by removing the seed source. It is also important to take care in cutting during the appropriate times (such as late summer/fall) as to not actually encourage growth. Removed plant material for the Class B shoreline weeds (purple loosestrife, garden loosestrife, and phragmites) will be securely bagged and disposed of in the garbage (not composted or green-wasted).

In areas of large infestation where native planting activities may occur after treatment, the use of weed tarps could be useful in lowering the risk of re-infestation. These sites need to be monitored to make sure new plants are not growing underneath the weed fabric or along the edges and that the tarps continue to be securely staked down.

Follow-up Control

The years following the initial control will continue to use a combination of herbicide treatment, cutting and hand pulling follow-up.

Schedule

Year 1
Survey the entire shoreline for the three regulated weeds. Following the survey, combine just acquired weed location data, historical weed location data, and the locations of Phase I treatment areas (existing restoration areas, pending restoration areas, and managed parks). Weed control work in year 1 will focus on these Phase I priority areas, ideally working downstream from site to site. Areas treated in year 1 will be surveyed at least two weeks following treatment to determine herbicide efficacy or effectiveness. During this survey re-treat any missed plants in the initial treatment area.

Year 2
Work in year 2 will entail surveying the entire river shoreline again, focusing on areas that were treated in year 1. This survey data will be compared to year 1 survey data to determine the control success of the year 1 treatment. Based on the control success of year 1 and what was accomplished control work will continue in Phase 1 priority areas and begin in Phase II locations, the areas just upstream of the previously treated priority areas. Also, any plants re-appearing in previously treated areas (Phase I areas) will be re-treated. In late summer/fall (at least two weeks after initial treatment) assess effectiveness of control methods and retreat, employ other strategies, such as seedhead removal as necessary.

Year 3
Survey work in year 3 will once again entail a survey of the shoreline regulated weeds on the entire river. Assuming good control in Phase I and Phase II locations, control work will now focus on the unmanaged Phase III riverbank areas. Control work in these areas should begin at the most up-stream uncontrolled areas of river bank and proceed downstream. Also, any plants re-appearing in previously treated areas (Phase I or II areas) will be re-treated. In late summer/fall (at least two weeks after initial treatment) assess effectiveness of control methods and retreat, employ other strategies, such as seedhead removal as necessary.

Year 4
Continue initial treatment of the remaining untreated Phase III areas, working in a downstream direction. Also, any plant re-appearing in previously treated areas (Phase I, II, or III areas) will be re-treated. In late summer/fall assess effectiveness of control methods and retreat, employ other strategies, such as seedhead removal as necessary.

Year 5
Continue initial treatment of the remaining untreated Phase III areas, working in a downstream direction. Also, any plants re-appearing in previously treated areas (Phase I, II, or III areas) will be re-treated. In late summer/fall (at least two weeks after initial treatment) assess effectiveness of control methods and retreat, employ other strategies, such as seedhead removal as necessary.

Year 6 and Year 7
Resurvey entire river and employ treatment strategies as necessary. Two years of post-surveys and adaptive treatment will account for any new infestations or hard to control areas to be controlled, insuring the success of the work.

A Treatment Chronology for Land Managers

In summary, a chronology of how to control the shoreline aquatic noxious weeds would proceed as follows:

1. Year 1
    a. Survey (mid-July)
    b. Individual spot spray with aquatic herbicide (end of July/early August)
    c. Re-survey (mid-August, two weeks after initially herbicide treatment)
    d. Follow-up spot spray (end of August)
2. Year 2
    a. Survey (mid-July)

b. Individual spot spray with aquatic herbicide (end of July/early August)
c. Re-survey (mid-August, two weeks after initially herbicide treatment)
d. Follow-up spot spray with aquatic herbicide or hand digging of remaining weeds (end of August)

3. Year 3
    a. Plant willow stakes and other native plants (winter) in effort to shade river and shade out the growth of invasive aquatic noxious weeds
    b. Survey (mid-July)
    c. Individual spot spray with aquatic herbicide or hand digging of remaining weeds (end of July/early August)

Brazilian elodea (*Egeria densa*)

Initial control (year 1)

Pretreatment survey of Brazilian elodea will occur in early to mid-July. The survey will be conducted from a small boat using a view tube to survey submerged plants. Plant locations will be recorded using a combination of GPS and sketched marks on detailed aerial photos and later transferred to a GIS file.

Areas of elodea infestation will be prioritized based on density, proximity to important ESA listed salmon habitat features and area that could affect the flow of water through the system. After identification of these areas the use of snorkel dredgers/hand pulling will be used. Dredging and hand-pulling will have to occur during the appropriate work window for salmon. It will be important to follow dredging protocol to insure that the effects of dredging by snorkelers (such as the disruption of sediment) are minimized and do not harm the sensitive species that use the river.

Snorkelers will target the top priority areas first and as the project continues work through the prioritization sites as possible. Surveys will be conducted each year to determine the extent of the infestation and assess how well the control methods are working.

The goal of this effort will be to see if dredging can keep critically important habitat for salmon open for passage as well minimize any hindrance to water flow between Lake Sammamish and Lake Washington. It is hoped that a routine schedule of dredging could become an effective way to control elodea in the Sammamish River until eradication is a possibility.

SECTION 8 - PLAN ELEMENTS, COSTS, AND FUNDING

Implementation of the Sammamish River IAVMP is scheduled to span five years, at a total estimated cost of $155,000. Table 9 outlines the tasks and estimated costs of implementation on an annual basis. The majority of the costs accrue in the first five years, the period of most aggressive treatment. As the project progresses, more funds are dedicated at detecting and controlling reintroduction of aquatic noxious weed species.

Total Cost of the Plan

Planning Costs

Many of the planning costs have already been incurred through the creation of this IAVMP. Approximately 75% of the cost of researching, planning for and writing this management plan came in

the form of a grant from the Washington State Department of Ecology's Aquatic Weeds Management Fund. The remaining costs came in form of salary match from King County Water and Land Resources Division staff. Additionally several stakeholders contributed their time reviewing the written document. Total planning costs are estimated at around $40,000.00.

Capital Costs

There are no capital costs associated with this IAVMP. It is not anticipated that any equipment will needed to be purchased.

Operational and Maintenance Costs

The majority of expenses associated with implementation of the Sammamish River IAVMP are operational and maintenance costs. These costs include hiring of herbicide contractors, mapping and surveying, follow-up weed removal, community outreach, and project administration & management (Table 9).

Table 9. Sammamish River IAVMP Budget.

Task		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Total
Noxious Weed Control	Diver and snorkel hand pulling/Dredging of Brazilian elodea (two days/year) in targeted location in the river only		$6,000	$6,150		$6,300		$6,500	$24,950
	Purple and Garden loosestrife control (1/5 of the shoreline per year initial treatment(herbicide application)) + (follow-up treatment using an I.P.M. strategy (herbicide, hand pulling, biocontrol, …)	$4,000	$7,000	$8,500	$10,000	$11,500	$7,500	$5,000	$53,500
	Phragmites control/eradication(herbicide treatment)	$500	$300	$300	$150	$150	$150	$150	$1,700
Weed Surveys	purple loosestrife and garden loosestrife survey (canoe)	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$10,500
	Brazilian elodea survey (canoe)	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$10,500
Education & Outreach		$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$10,500
Project Administration and Report Writing		$4,760	$4,410	$4,760	$4,760	$4,760	$4,760	$4,760	$32,970
	sub totals	$13,760	$22,210	$24,210	$19,410	$27,210	$16,910	$20,910	$144,620
			Project Total						$144,620

Sources of Funding

Funding for implementation of the Sammamish River IAVMP may come from a combination of sources that will change as the project progresses. Potential sources of funding such as grants, self-funding by river-side municipalities, and non-profits in-kind time were all considered by the Steering Committee. Funding of this project will likely include a blend of different funds, grants, matching cash funds and matching in kind volunteer hours.

Grants

The program has applied for a grant from Washington State Department of Ecology's Aquatic Weeds Management Fund (AWMF) for the writing of this IAVMP. This IAVMP has been developed to be consistent with all AWMF guidelines and requirements so a local jurisdiction could apply for this funding source again and fund the implementation of the project. Given the waterbody-wide extent of the infestations, potential and actual harm that the plant infestations are causing salmonid species, and the support of interested parties along the River, the awarding of an AWMF grant is a possibility.

The Cooperative Watershed Management grant program exists within the WRIA 8 grant programs. The project plan will need to be in line with the goals and objectives of the WRIA 8 Salmon Recovery Plan. Given that this IAVMP project would have a direct impact on improving the Sammamish River habitat for ESA listed Chinook salmon, this project may be a good fit for this grant program.

Matching Funds

Awarding of the Ecology's AWMF grant requires matching funds. Requiring matching funds distributes the responsibility of funding between the state agency (Ecology) and the local stakeholders (municipalities along the River, WIRA 8, and the King County Noxious Weed Control Program). Both cash match and in-kind and/or interlocal match are potential sources of matching funds that could be used to fulfill this requirement.

Long-term Sustainability

The long term sustainability of this project is dependent on the municipalities along the river and the commitment of Sammamish River residents to follow-up weed control and the ability of the staff of the King County Noxious Weed Control Program to communicate weed control techniques, strategies and priorities. In the absence of the AWMF grant funding options will be re-evaluated by the Steering Committee.

SECTION 9 – MONITORING, EVALUATION, AND IMPLEMENTATION

Monitoring

Yearly surveying and monitoring of emergent and submerged aquatic noxious weeds will be conducted along the Sammamish River. These surveys will help guide noxious weed control efforts and provide a year-to-year baseline for progress towards weed control. During the surveys, mapping of the aquatic noxious weeds will be done using aerial photos and/or GPS data loggers. Collected data will then be transferred to GIS.

Evaluation of the Plan

The effectiveness of the plan will be evaluated yearly by the Project team/Implementation Committee (see below). Adaptive changes will be made as needed. Year-to-year comparisons of the monitoring data will be used to evaluate trends in specific target species abundance and distribution. The results of these comparisons will guide control efforts and may result in a change in future control strategies. Success of the plan will be measured by the reduction of the target noxious weed species.

Implementation

The implementation of the plan will follow the process outlined below:

Convene a project Implementation Committee. This group will consist of King County staff and interested parties who are invested in the health of the Sammamish River, likely members of the IAVMP Steering Committee. They will control how the plan in implemented.

Identify Funding Sources. The most likely source for funds to support the implementation of the IAVMP is the Washington State Department of Ecology Aquatic Weeds Management Fund (AWMF). Other local and regional grants as well as possible money from local municipalities will be pursued. The AWMF grant requires matching funds and time from the local agency and community and could fund the first three to four years of the project. This grant requires that work is done in conjunction with the local government. Given that there are several municipalities along the river any one of them could be the lead agency but will need the other local jurisdictions and King County Department of Natural Resources and Parks to ensure the project is successful. During the final year of the grant's funding, the need for future funding will be assessed by the Implementation Committee.

Select an Herbicide Contractor. An applicator will be selected for treatment of each of the three regulated shoreline weeds outlined in the IAVMP. The treatments will be done either "in house" by experienced King County DNRP or local municipal employees or by a competent contractor.

Select method for in water work: King County and local municipalities will work together to review and assess doing snorkel dredging and hand pulling "in house" by experienced King County DNRP staff or by a competent contractor.

Application of Herbicide. Application of herbicides will be completed as prescribed in the IAVMP, unless consultation with the citizens, local municipalities, Ecology and/or the applicator leads to defensible changes in the plan.

Public Education and Communication. Land owners along the Sammamish River will be notified about up-coming herbicide applications as determined by the NPDES permit, the results of yearly monitoring efforts, and any major changes made to the plan via mail, website postings on the King County and local municipal websites.

Monitoring Surveys. Surveys will be done yearly by King County staff with the help of local municipalities. Surveys will be done at the same time each year in order to get a comparable measure of the plants distribution and density.

Manual follow-up. Each year in late summer, a few weeks after herbicide treatment occurs, local jurisdiction staff will manually remove the reproductive parts of plants that were not treated. This will include removal of purple loosestrife flower heads, gathering of any nuisance dead water lily mats, and milfoil fragments.

Long-term Monitoring and Maintenance. This will be done by King County and the local jurisdictions after the satisfactory completion of the implementation plan.

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